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# MONTHLY NOTICES

OF THE

# ROYAL ASTRONOMICAL SOCIETY.

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VOL. LX. No. 8. MAY 1900.

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: ASTRONOMICAL SECTION.

At the request of Dr. A. A. Common, F.R.S., the Council call the attention of the Fellows of the Society to the fact that meetings of an Astronomical Section will be held at the British Association meeting at Bradford, 1900 September 5–12.

Dr. Common has been elected Chairman of the Section, and requests that authors of papers to be read at the meetings should send their communications to him at 63 Eaton Rise, Ealing, London, W., or to the Secretary of the British Association, Burlington House, London, W.

# MONTHLY NOTICES

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# ROYAL ASTRONOMICAL SOCIETY.

VOL. LX. MAY 11, 1900. No. 8


E. B. KNOBEL, Esq., PRESIDENT, in the Chair.

Alexander Foote, J.P., F.S.A. Scot., 111 Warwick Road, Earl's Court, S.W., and Mall Park, Montrose, Scotland ; and

Désiré Ernest Lebon, Agrégé de l'Université, Professeur de Mathématiques au Lycée Charlemagne, 4 bis, rue des Écoles, Paris,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :—

Arthur H. Baker, B.A., Headmaster Basnett Road Board School, Lavender Hill, S.W. ; and 28 Cautley Avenue, Clapham Common, S.W. (proposed by Thomas Lewis) ;

William Henry Colegrave, Master Mariner (P. & O. Service), Little Tew, Enstone, Oxford (proposed by Duncan Forbes) ; and

Guy François Comte Meredyth de Miremont, Orleans Club, St. James's, London, S.W. (proposed by Duncan Forbes).

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Fifty-two presents were announced as having been received since the last meeting, including amongst others :—

F. K. Ginzel, Specieller Kanon der Sonnen- und Mondfinsternisse, presented by the author ; Harvard Observatory, Annals,

vol. xliv. (E. C. Pickering, Revision of the Harvard Photometry), presented by the Observatory; Royal Observatory, Lisbon, O Eclipse de Sol de 1900 Maio 28, presented by the Observatory; Facsimile of Captain Cook's original Observation of the Transit of *Venus*, 1769 (lantern slide), presented by Rev. E. Ledger.

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*On the Alleged Rotation of the Spiral Nebula Messier* 51 *Canum Venaticorum.* By H. H. Turner, M.A., F.R.S., Savilian Professor.

In his recently published second volume of *Photographs of Stars, Star Clusters, and Nebulæ* Dr. Isaac Roberts gives measures of a photograph of M 51, taken in 1898, and a comparison with Lord Rosse's measures in 1872–74, whence he suggests that the nebula has rotated round its central nucleus through over 100′ in 47 years. As a movement of this magnitude in a nebula, if well established, is naturally of the first importance, I wrote to Dr. Roberts asking for particulars as to his determination of the zero of position-angle. He very kindly sent me full particulars and a copy of the original negative. On this copy I found that there were three Groombridge stars, also contained therefore in the Radcliffe (1845·0) Catalogue; and that these have been recently observed at Greenwich and will appear in the forthcoming Ten-year (1890·0) Catalogue. Places of these stars, which were kindly supplied by the Astronomer Royal, give an independent check on the zero of position-angle, and my measures of the plate indicate a zero differing by about a degree from that of Dr. Roberts. This would mean that a large part, if not the whole, of the movement assigned by him to the nebula may be due to instrumental error.

The reasons for believing that the position-angles are affected with systematic error were given in full, as was only proper in challenging the accuracy of the work of another astronomer; and I wrote to Dr. Roberts informing him of my results. He lost no time in re-examining the question, and I received from him, under date May 8, the following letter :—

"Referring to the spiral nebula M 51 *Canum*, I have obtained two photographs upon which are *star-trails* : one trail on each plate extends across the nebula. By measurements from these I find a difference of 1° 19′ in the zero of the centre of the nebula when it is compared with the zero deduced by interpolated trails, upon which I relied in the measurement of position-angles published in my second volume. Consequently the position-angles therein given on pp. 25 and 109 are 1° 19′ in excess, and this correction will have to be applied when comparisons are made with other measurements.

"I intend shortly to send to each possessor of vol. ii. a note of this and of four minor *errata* which have been found in the volume."

(Signed) "ISAAC ROBERTS."

As it is clearly preferable that a correction of this kind should be announced by the author himself, I withdraw my paper, which arrives at substantially the same result. Perhaps I may be permitted to add a word or two of cordial recognition of the way in which Dr. Roberts has throughout spared no pains to establish the truth, whatever it might be. He placed all possible information in my hands for elucidating the matter; and, when I found cause to suspect an error, lost no time in independently examining his results. His re-examination at first conducted him again to his published conclusion; but he was not content until he had checked it in yet another way by new photographs, with the result above quoted.

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*The Duration of the greater Sun-spot Disturbances for the years* 1881–99. By the Rev. A. L. Cortie, S.J.

The number of solar drawings made at Stonyhurst during the last nineteen years amounts to 3,454, or an average of slightly over 180 each year. All the chief disturbances that have occurred during this period have been drawn at some time of their life history. In order to study the possible connection between individual magnetic storms and solar spot outbursts Father Sidgreaves has caused all the chief solar disturbances that have been recorded during these years to be charted, and their life histories to be entered in a ledger. These charts and ledger have been made use of in drawing up the present paper. The charts bear each a rotation number in continuation of Carrington's numbers, and cover the rotations from 364 to 618. Only the larger spot groups, whether single or composite in character, have been selected for entry—such as reached an area of $\frac{1}{1000}$ of the visible solar hemisphere during any part of their life history. A few other groups have been admitted, on account of their being either recurrences of these greater disturbances, or in some way connected with them. The number of such disturbances that have appeared during the 255 solar rotations under discussion amounts to 115. The present paper deals chiefly with the duration of these greater solar disturbances.

In the following table the first column gives the year, and the second the number of the groups according to the Stonyhurst charts. Those numbers which bear an asterisk denote groups that were both born and died in the visible solar hemisphere. Groups which are bracketed are obviously connected as recurrences of the same disturbance. The third and fourth columns

give to the nearest degree the mean heliographic longitude and latitude of a point which was judged by an inspection of the charts to be the centre of the group or groups covering the disturbed area. In compiling these columns our indebtedness to the Greenwich volumes giving the positions of the various groups is very great. The fifth and sixth columns give the dates of the first and last appearance of the disturbance; the seventh column shows the number of times it passed the central meridian of the visible hemisphere, and the eighth its visible duration in days; the last column states the character of the disturbance. If only one group of spots was concerned, even though it might have been of large dimensions and of great extent in area, it is entered as single. If more than one group caused the disturbance the entry is "composite." The line of distinction between these two classes of disturbance was sometimes difficult to draw when a group was very large and extended. Following the table a brief summary, with notes of some of the more obvious deductions to be drawn from an inspection of the charts, is given.

TABLE I.

| Year. | Group Number. | Heliographic Long. | Heliographic Lat. | First seen. | Last seen. | Central Times. | Visible Duration, Days. | Character of Disturbance. |
|---|---|---|---|---|---|---|---|---|
| | | ° | ° | | | | | |
| 1881 | 1 | 350 | −12 | May 30 | July 2 | 2 | 33 | Single |
| | 2 | 312 | +24 | July 25 | Aug. 4 | 1 | 10 | ,, |
| | 3 | 289 | +16 | Oct. 14 | Dec. 17 | 3 | 64 | Composite |
| | 4 | 226 | +13 | Nov. 13 | 23 | 2 | 40 | ,, |
| 1882 | 5 | 88 | −18 | Apr. 10 | Apr. 23 | 1 | 13 | Single |
| | 6 | 64 | −29 | 12 | May 24 | 2 | 42 | ,, |
| | 7 | 176 | +23 | May 1 | June 9 | 2 | 39 | ,, |
| | *7a | 67 | +22 | Sept. 2 | Oct. 2 | 2 | 30 | ,, |
| | 8 | 44 | −22 | 24 | Dec. 1 | 3 | 68 | Composite |
| | 9 | 165 | +16 | Oct. 13 | Nov. 20 | 2 | 38 | ,, |
| | *10 | 121 | +19 | 20 | Dec. 20 | 3 | 61 | Single |
| 1883 | 11 | 15 | + 8 | Feb. 11 | Feb. 22 | 1 | 11 | ,, |
| | *12 | 73 | − 9 | June 1 | Aug. 19 | 4 | 79 | ,, |
| | 13 | 36 | +11 | 25 | 18 | 3 | 54 | ,, |
| | 14 | 133 | −22 | Sept. 8 | Nov. 14 | 3 | 67 | ,, |
| | 15 | 127 | +11 | Oct. 8 | 12 | 2 | 35 | ,, |
| | 16 | 36 | −12 | 12 | Jan. 13 | 4 | 93 | Composite |
| 1884 | 17 | 27 | −10 | Mar. 31 | July 17 | 5 | 108 | Single |
| | 18 | 151 | − 8 | Apr. 21 | 14 | 4 | 84 | ,, |
| | 19 | 224 | +16 | Aug. 24 | Sept. 29 | 2 | 36 | ,, |
| | 20 | 15 | +15 | Sept. 6 | Dec. 8 | 4 | 93 | Composite |

| Year. | Group Number. | Heliographic Long. | Heliographic Lat. | First seen. | Last seen. | Central Times. | Visible Duration, Days. | Character of Disturbance. |
|---|---|---|---|---|---|---|---|---|
| 1884 | 21 | 55° | +8° | Dec. 20 | Jan. 1 | 1 | 12 | Single |
| 1885 | 22 | 250 | −14 | Jan. 30 | June 25 | 6 | 146 | Composite |
| | 23 | 123 | +12 | Apr. 3 | 8 | 3 | 66 | Single |
| | 24 | 250 | +11 | May 18 | Aug. 19 | 4 | 93 | ,, |
| | 25 | 54 | −17 | June 1 | 7 | 3 | 67 | Composite |
| | 26 | 355 | − 5 | 6 | July 15 | 2 | 39 | Single |
| | 27 | 168 | −13 | 23 | Aug. 25 | 3 | 63 | Composite |
| 1886 | 28 | 34 | − 6 | Jan. 8 | May 31 | 6 | 143 | ,, |
| | 29 | 71 | −10 | Mar. 29 | Sept. 15 | 7 | 170 | Single |
| | 30 | 333 | + 9 | May 2 | June 28 | 3 | 57 | ,, |
| | 31 | 302 | −14 | June 3 | Aug. 5 | 3 | 63 | ,, |
| 1887 | *32 | 92 | − 8 | May 14 | Sept. 4 | 5 | 113 | Composite |
| | *33 | 87 | − 5 | Oct. 2 | Oct. 4 | 1 | 2 | Single |
| | 34 | 83 | − 8 | Dec. 14 | Jan. 21 | 1 | 38 | ,, |
| 1888 | 35 | 274 | − 8 | May 11 | May 23 | 1 | 12 | ,, |
| | *36 | 270 | − 8 | July 6 | July 17 | 1 | 11 | ,, |
| | 37 | 275 | − 8 | Aug. 8 | Aug. 10 | 1 | 2 | ,, |
| | 38 | 277 | − 6 | 28 | Sept. 9 | 1 | 12 | ,, |
| | 39 | 165 | −14 | Sept. 6 | Dec. 9 | 3 | 94 | Composite |
| 1889 | 40 | 35 | − 7 | June 16 | Aug. 20 | 3 | 65 | Single |
| | *41 | 82 | − 8 | July 14 | Sept. 4 | 3 | 52 | ,, |
| | *42 | 156 | −22 | Aug. 2 | Oct. 23 | 4 | 82 | Composite |
| 1890 | 43 | 37 | +21 | 25 | 2 | 2 | 38 | Single |
| | 44 | 28 | −23 | Oct. 19 | Nov. 1 | 1 | 13 | ,, |
| | *45 | 309 | +20 | Nov. 22 | Dec. 28 | 2 | 36 | Composite |
| 1891 | 46 | 223 | +20 | July 6 | 18 | 7 | 165 | ,, |
| 1892 | 47 | 263 | −22 | Sept. 25,'91 | Mar. 5, '93 | 20 | 527 | ,, |
| | 47*a* | 271 | −20 | Nov. 14 | Dec. 24 | 2 | 40 | Single |
| | 47*b* | 261 | −26 | Jan. 18 | Mar. 17 | 3 | 59 | ,, |
| | 47*c* | 266 | −19 | May 23 | June 5 | 1 | 13 | ,, |
| | 47*d* | 270 | −20 | Jan. 24, '93 | Feb. 6, '93 | 1 | 13 | ,, |
| | 48 | 190 | +25 | Dec. 19, '91 | Jan. 27, '92 | 2 | 39 | ,, |
| | 49 | 32 | +28 | Mar. 20 | Apr. 2 | 1 | 13 | ,, |
| | 50 | 83 | −14 | Apr. 17 | May 22 | 2 | 35 | ,, |
| | 51 | 147 | +12 | June 10 | Sept. 29 | 5 | 111 | ,, |
| | 52 | 40 | −31 | 13 | July 19 | 2 | 36 | ,, |
| | 53 | 92 | +11 | July 4 | Oct. 5 | 4 | 93 | ,, |
| | 53*a* | 94 | +11 | Oct. 29 | Nov. 1 | 1 | 3 | ,, |

| Year. | Group Number. | Heliographic Long. | Heliographic Lat. | First seen. | Last seen. | Central Times. | Visible Duration, Days. | Character of Disturbance. |
|---|---|---|---|---|---|---|---|---|
| | | ° | ° | | | | | |
| 1892 | 54 | 5 | +15 | Oct. 2 | Oct. 12 | 1 | 10 | Single |
| | *55 | 24 | −26 | 27 | Dec. 2 | 2 | 36 | Composite |
| | 56 | 142 | −24 | Nov. 13 | Nov. 25 | 1 | 12 | Single |
| | 57 | 320 | −24 | Dec. 24 | Jan. 5 | 1 | 12 | ,, |
| 1893 | 58 | 15 | −13 | Jan. 16 | 27 | 1 | 11 | ,, |
| | 59 | 108 | −11 | Feb. 5 | Feb. 18 | 1 | 13 | ,, |
| | 60 | 267 | +22 | Mar. 19 | Apr. 28 | 2 | 40 | ,, |
| | *61 | 141 | −11 | Apr. 27 | May 25 | 2 | 28 | ,, |
| | 62 | 78 | −21 | 29 | July 5 | 3 | 67 | ,, |
| | 63 | 320 | −15 | June 5 | Aug. 11 | 3 | 67 | Single |
| | 64 | 291 | −19 | 13 | Sept. 9 | 4 | 88 | ,, |
| | 65 | 299 | +14 | Aug. 2 | Nov. 2 | 4 | 92 | ,, |
| | 66 | 303 | − 8 | 3 | Oct. 5 | 3 | 63 | ,, |
| | 66*a* | 104 | −16 | 15 | Aug. 27 | 1 | 12 | Composite |
| | 67 | 173 | − 9 | 19 | Nov. 12 | 4 | 85 | ,, |
| | 68 | 221 | − 8 | Sept. 4 | Sept. 14 | 1 | 10 | Single |
| | 69 | 340 | − 7 | Oct. 18 | Nov. 25 | 2 | 38 | ,, |
| | 70 | 63 | − 6 | Nov. 9 | 20 | 1 | 11 | ,, |
| | 71 | 324 | − 8 | 16 | Feb. 16 | 4 | 92 | Composite |
| 1894 | 72 | 190 | −30 | Feb. 15 | Mar. 1 | 1 | 14 | Single |
| | 73 | 33 | +21 | Mar. 28 | Apr. 8 | 1 | 11 | ,, |
| | *74 | 152 | −13 | 30 | June 16 | 4 | 78 | ,, |
| | 75 | 356 | −27 | Apr. 3 | May 8 | 2 | 35 | ,, |
| | *76 | 290 | +17 | 4 | 12 | 2 | 38 | Composite |
| | *77 | 180 | −18 | May 11 | Aug. 9 | 4 | 90 | Single |
| | 78 | 130 | + 9 | June 10 | 6 | 3 | 57 | ,, |
| | 79 | 76 | −13 | 14 | 19 | 3 | 66 | Composite |
| | 80 | 182 | +12 | July 2 | Sept. 9 | 3 | 69 | Single |
| | 81 | 27 | + 6 | Aug. 11 | 14 | 2 | 34 | ,, |
| | 82 | 60 | −12 | Sept. 5 | Nov. 4 | 3 | 60 | Composite |
| | 83 | 77 | +11 | Nov. 26 | Dec. 6 | 1 | 10 | Single |
| | *84 | 307 | −19 | Dec. 10 | Feb. 5 | 3 | 57 | ,, |
| 1895 | 85 | 168 | −15 | 15 | Dec. 26 | 1 | 11 | ,, |
| | 86 | 58 | −10 | Jan. 21 | Apr. 22 | 4 | 91 | ,, |
| | 87 | 300 | +23 | Apr. 20 | July 16 | 4 | 87 | ,, |
| | 88 | 24 | +10 | Aug. 1 | Nov. 2 | 4 | 93 | ,, |
| | 89 | 23 | −16 | Sept. 26 | 30 | 3 | 65 | ,, |

| Year. | Group Number. | Heliographic Long. | Heliographic Lat. | First seen. | Last seen. | Central Times. | Visible Duration, Days. | Character of Disturbance. |
|---|---|---|---|---|---|---|---|---|
| 1895 | *90 | 326° | +9° | Oct. 28 | Nov. 29 | 2 | 32 | Single |
| | 91 | 303 | −13 | Dec. 21 | Jan. 29 | 2 | 39 | ,, |
| 1896 | 92 | 227 | −15 | Feb. 2 | Mar. 2 | 2 | 29 | ,, |
| | 93 | 258 | +15 | 18 | 21 | 2 | 32 | ,, |
| | 94 | 131 | +17 | Mar. 25 | Apr. 6 | 1 | 12 | ,, |
| | 95 | 34 | +16 | Apr. 2 | 13 | 1 | 11 | ,, |
| | 96 | 72 | −10 | May 26 | June 4 | 1 | 9 | ,, |
| | *97 | 296 | −12 | Aug. 26 | Sept. 30 | 2 | 35 | ,, |
| | 98 | 66 | +12 | Sept. 10 | Oct. 13 | 1 | 33 | Composite |
| | 99 | 72 | −16 | Nov. 3 | Dec. 9 | 1 | 36 | Single |
| 1897 | 100 | 345 | − 6 | Jan. 3 | Apr. 5 | 4 | 92 | ,, |
| | 101 | 217 | + 5 | 20 | May 16 | 5 | 116 | Composite |
| | 102 | 263 | −10 | Apr. 28 | Aug. 27 | 5 | 121 | ,, |
| | 103 | 72 | − 6 | Aug. 2 | Oct. 7 | 3 | 66 | Single |
| | 104 | 32 | − 9 | 12 | Sept. 13 | 2 | 32 | ,, |
| | 105 | 206 | +10 | Dec. 6 | Jan. 15 | 2 | 40 | ,, |
| 1898 | 106 | 96 | − 8 | Jan. 18 | Mar. 18 | 3 | 59 | ,, |
| | 107 | 124 | −12 | Mar. 6 | May 1 | 3 | 56 | ,, |
| | *108 | 238 | −12 | Aug. 11 | Nov. 6 | 4 | 87 | ,, |
| | 109 | 310 | +14 | Sept. 27 | 3 | 2 | 37 | ,, |
| 1899 | 110 | 219 | − 9 | Mar. 15 | Apr. 12 | 2 | 28 | ,, |
| | 111 | 330 | + 5 | June 24 | July 5 | 1 | 11 | ,, |
| | *112 | 181 | −11 | 15 | Aug. 2 | 3 | 48 | ,, |

*Summary of the Disturbances.*

The rotations of the first half of 1881, those from 364 to 371, were free from greater disturbances, the first charted (Greenwich numbers 485, 500, 503) occurring during May, June, and July. Rotations 373 and 374, covering the months of August, September, and the first half of October, were also without greater spot groups. The three next rotations—375, 376, and 377—were disturbed, and were succeeded by three others—378, 379, and 380—without any great disturbance. Another set of three—381, 382, 383 (1882 March 27·76–June 17·46)—were disturbed, and these again were succeeded by yet another triplet—384, 385, 386 of solar calm. Four more rotations, 387–390, occurred before the end of 1882, and these were all disturbed. Of the five rotations, 391–395, covering the months 1883 January to May 10, only one, 393, had any signs of greater disturbance. But after these preliminary fluctuations a period of fourteen rotations commenced with 396

(1883 May 10·86), and terminated with 411 (1884 July 20·08), which were all more or less disturbed. After a breathing space of one rotation, 412, the disturbances were resumed, covering an interval of five rotations, 413 to 417 (1884 Dec. 31·27). After the lapse of another single rotation the eight rotations 419 to 426 (1885 January 26·11–September 2·13) were all subject to greater disturbances, 424 being especially affected. The four next, 427–430, were free from outbursts (1885 December 20·23). Ten rotations, 431–440, cover the period from this date to 1886 September 18·98, and they were all disturbed. This set is answered by another of eight rotations, 441–448, in a state of quiescence, thus covering the interval to 1887 April 25·47.

The solar surface, therefore, with but two short periods of rest, each extending over one rotation only, was continuously subject to these greater disturbances during the period of time from 1883 May 10·86–1885 September 2·13. After this date the fluctuation was four calm and ten disturbed rotations until 1886 September 18·98. Then ensued a distinct lull in the disturbed state of the Sun. In this connection it may be recalled, as was pointed out in a former paper (*Monthly Notices, R.A.S.* vol. xlvii. No. 1), that bands in the spectra of sun-spots—indicating presumably a cooling in the absorbing materials constituting the spots—began to appear at the commencement of 1885, and disappeared with the almost abrupt dropping of the sun-spot curve in the autumn of 1886.

After a period of rest, rotations 441 to 448, a new series of disturbances, intermittent in character, commenced in 1887 May —rotation 449. Six rotations—449 to 454—saw the life histories of two connected disturbances, two rotations—455, 456—intervened ; and the same disturbance presumably, from its latitude and longitude, broke out again, and remained for yet two more rotations—457, 458. Four rotations of rest then ensued, covering the period 1888 January–May 11, and again a set of four groups broke out in a restricted area, which were presumably due to a common cause ; group 35 occupying the rotation 463, rotation 464 being calm, and groups 36, 37, and 38 occurring in rotations 465, 466, 467 (1888 August 28·15). A new group, 39, appearing in rotation 467, caused the next rotation, 468, to be disturbed ; 469 was then undisturbed, and group 39 again reappears in 470. The intermittent character of the action of the presumed causes of allied disturbances, the presumption resting on the identity of mean position of the several groups of spots, is very remarkable in these disturbances during the period of minimum spot activity. The six rotations 471 (1888 December 15·33) to 476 (1889 April 30·90) were quiet, while the following six, 477 (1889 May 28·12) to 482 (1889 October 11·28), were disturbed. Then came a long calm, extending over the ten rotations 483–492 (1889 November 7·58–1890 August 7·31), which closed the spot cycle. Group 40, the region of which had been disturbed since 1888 July 6, and group 41 were the last large groups of

this cycle. It is worthy of note that all the disturbances, eleven in number, which appeared in the rotations 411 to 492, covering the period of this solar minimum, were observed in the southern hemisphere of the Sun. In rotation 482, just before the long period of calm closing the cycle, appeared group 42 in south latitude 22°, which, as far as these greater disturbances are concerned, heralded the advent of a new cycle. It did not, however, commence with any appearance of continuity until group 43 broke out in north latitude 21°. As the six rotations 471 to 476 of calm were responded to by six other rotations of disturbance in the year 1889, so now again six disturbed, 493–498 (1890 August 7·31–1891 January 18·09), are followed by six undisturbed rotations, numbered 499 to 504 (1891 January 18·09–June 30·71). These alternating equal periods of calm and unrest, noticed before in the sets of rotations in the years 1881 and 1882 before the beginning of the maximum, are at least curious if merely the result of coincidence.

The new series of disturbances which commenced in rotation 505 continued for no less than sixty-seven rotations (1891 June 30·71–1896 July 1·14). This, the second maximum which occurred during the years under discussion, was marked by considerably more disturbances than was the former maximum, the ratio being about 53 to 28. During this maximum also a region of the solar surface comprised between the limits 249° to 281° of longitude and 13° to 27° of south latitude was the seat of continuous disturbance from 1891 September 25 to 1893 March 5, and of intermittent disturbance for months afterwards. Four exceptionally large groups, which were all connected the one with the other, broke out during this time—numbered $47_a$, $47_b$, $47_c$, $47_d$ in the table—with thirteen other groups of smaller dimensions. Group $47_b$, indeed, was the largest group as yet recorded either at Greenwich or Stonyhurst. The duration of this disturbance reached 527 days. A full discussion of this extraordinary outburst is reserved for a future occasion. Another long-continued disturbance was No. 46, which lasted for 165 days. The region of this disturbance, 20° N. latitude, corresponding to 22° S. latitude of group 47, had showed signs of unrest since 1891 April 19. From a study of these and similar outbursts it would seem probable that the force causing the disturbance acts at first in an intermittent and relatively feeble manner, until, gathering ever-increasing strength, it is manifested by an outburst of great dimensions, to be in turn followed until quiescence by yet more intermittent outbreaks. The high latitude of the spot groups in this maximum is worthy of note.

The single groups 63, 64, 65, 66 were all close together, and seemingly were connected. They were also not very far removed from the seat of action of the giant disturbance of this maximum. The composite disturbance 71 appeared in a region which continued to be intermittently disturbed until 1895 January 12. During the last three months of 1893 and the first three of 1894,

in the period covered by rotations 534 to 540, the groups appeared in low latitudes ; but in rotation 540 a large group, No. 72, broke out in S. latitude 30°, followed, with the intermission of one group, by two others, 73 and 75, also in high latitudes, thus staying the gradual descent of the groups in latitude with the advance of the cycle. Even in 1896, towards the end of the maximum, the mean latitude of the groups was fairly high, about 16°. There seem to be signs of a subsidiary spot cycle being superposed on the main cycle. Groups 84, 85, 87, 88, 89, occurring when the maximum was well advanced, were all characterised by rapid growth and decline. With regard to other groups of the period, it may be noted that 82 is a possible recurrence of 79, while 85 is a probable recurrence of 77. The connecting link between these last two disturbances is a minor outbreak in the same region in 1894 November. Subsequently, too, the same region was again disturbed, though in a less degree, in 1895 January.

After the disturbances during this long-continued period of unrest had at length subsided, but two rotations of quiet intervened, 572 and 573, when a remakable continuous stream of most irregular spots, extending at least 25° in longitude, appeared during the two following rotations, 574 and 575. No sooner had it vanished than its counterpart appeared, also during two rotations, 576, 577, S. of the equator, of almost equal length, of similar character, and in approximately the corresponding longitude and latitude. Moreover, both these streams of spots were almost exactly parallel to each other, and inclined at the same angle of about 15° to the equator. This is a remarkable, but by no means a solitary, instance of correlated and answering disturbances in the same position N. and S. of the equator. The subject needs more rigorous investigation, though even a glance through the charts indicates the existence of the phenomenon. Among such groups 83 seems to answer 82, 89 responds to 88, and 93 has its counterpart in 92.

After the disappearance of these groups the solar surface continued to be disturbed through eleven rotations, 578 to 588, followed by a period of rest during two rotations, thus bringing the record down to the end of 1897. It must be noted, however, that during these rotations there was quite a sudden fall in the latitude of the five groups, 100 to 104, covering them, the drop in latitude being accompanied by a simultaneous increase in duration. The region of group 101 continued to be disturbed until November 21 by small and short-lived groups. The great decline in the mean distance of these spots from the equator has already been called attention to by the Astronomer Royal in *Monthly Notices*, vol. lix. 1. After the outburst, No. 104, the Sun was almost spotless for two rotations, 589 and 590. The next three groups in order of numbering extended over five rotations, 591 to 596 (1897 December 1·32–1898 May 14·18). For the three next rotations, 597 to 599, extending through the months 1898

May to August, the Sun was again almost entirely devoid of spots. The group 108 appeared at first small in area in rotation 600, and together with group 109 caused this and the two following rotations to be disturbed. Rotation 604 (1898 November 20·89) was the commencement of another quiet series of rotations, which lasted until the end of 607 (1899 March 10·21). The two next rotations, 608, 609, saw the life history of group 110; rotation 610 was calm; 611 to 613 were affected by groups 111 and 112; and the remaining six rotations of the years under review, 614 to 618 (1899 August 20·61–1900 January 4·09), maintained an undisturbed appearance.

In the yearly summaries of the Greenwich results for sun-spot area and position, which are published in the *Monthly Notices*, it has been noticed that the preponderance of all the sun-spots has for several years belonged to the southern hemisphere of the Sun. The same is true for the greater disturbances tabulated in this paper. Up to the end of 1886 such outbursts were equally distributed between the two hemispheres, 16 to each; but since a minimum period set in, in the year 1887, the southern hemisphere has maintained a decided supremacy until the termination of the next minimum, the numbers being 55 in the southern against 28 in the northern hemisphere.

With regard to the duration of the several groups, assuming Carrington's value of 25·38 days as the period of a solar rotation, the 115 groups are distributed as follows :—

| Between rotations. | Number of groups. | Percentage. |
|---|---|---|
| 0 to 1 | 28 | 24·3 |
| 1 to 2 | 34 | 29·6 |
| 2 to 3 | 24 | 20·9 |
| 3 to 4 | 19 | 16·5 |
| 4 to 5 | 5 | 4·3 |
| 5 to 6 | 2 | 1·7 |
| 6 to 7 | 2 | 1·7 |

One abnormal disturbance of 20·7 rotations is omitted.

Hence it appears that the greater number of disturbances, nearly 30 per cent., live through a period between 1 and 2 rotations.

This conclusion is borne out if the whole number of days of disturbance be divided by the total number of disturbances. From this we get that the average life of a disturbance is 56·0 days, or a little more than two rotations. If we take those groups only which were born and also died on the Sun's visible hemisphere, numbering 19 in all, and get a mean in this manner, the result is that the average life of a solar disturbance is 52·4 days, or again slightly more than two solar rotations.

The average duration, then, of a sun-spot disturbance—for we have neglected altogether the disturbances manifested by

means of faculæ—appears to be of the period of two solar rotations.

Besides this conclusion, which was the chief object for which the above table was prepared, the following points for more detailed investigation and study are suggested by the summary review of the disturbances during the last nineteen years :—

(1) In the alternations of quiet and disturbed periods, seven of twenty-two are of equal duration reckoned in rotations of the Sun. Is this equality of alternating periods merely a coincidence ?

(2) The action of the foci of disturbance differs in the maximum and in the minimum periods of sun-spots. In the former it is at some time continuous, in the latter always intermittent.

(3) In a set of allied disturbances the mode of action of the force causing them is at first intermittent, then culminates in a grand outburst, and dies away in another set of intermittent disturbances.

(4) The superposition of minor subsidiary cycles of disturbance upon the main cycle of eleven years seems to be apparent.

(5) Groups towards the end of the period of maximum seem to grow and decline very rapidly.

(6) There seems to be no doubt that allied disturbances occur in identical positions north and south of the equator of similar character and extent.

(7) The noteworthy concentration of disturbances in the southern hemisphere of the Sun during the last maximum and the preceding minimum suggests an answering concentration of disturbances in the northern hemisphere in the coming maximum.

*Stonyhurst College Observatory:*
1900 *May* 5.

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*Note on Measures by Professor Barnard of two Standard Points on the Moon's Surface.* By S. A. Saunder, M.A.

In a paper communicated to the Society last January (*ante*, p. 174) attention was called to the increase of accuracy in selenographic positions which might be attained by measuring from a well-determined point instead of from the limb, and to the suitability of Mösting A as an origin. It was my good fortune that Professor Barnard was present at the meeting at which the paper was read, and the next day he most kindly offered to measure a few points on the Moon itself if the results would be of any assistance to me. This generous offer I gladly accepted, and I have now received from him the particulars of measures made on April 7 and 9, with the full aperture of the 40-inch telescope of the Yerkes Observatory, and a magnifying power of

700 diameters. The measures made were of the distances and position-angles of the lines joining the centres of Mösting A, Ptolemaus A, and Triesnecker B. Each position-angle was measured four or five times on each night, and each distance eight or nine times. These measures I have reduced by the methods described in the paper referred to with the following results.

Assuming Professor Franz's position for Mösting A and denoting the coordinates of the other points by the suffixes $p$, $t$ respectively, Professor Barnard's measures give :—

| | | |
|---|---|---|
| 1900 Apr. 7 | $\xi_p = -\cdot0142$ | $\eta_p = -\cdot1478$ |
| | $\xi_t = +\cdot0071$ | $\eta_t = +\cdot0202$ |
| | $\xi_t - \xi_p = +\cdot0212$ | $\eta_t - \eta_p = +\cdot1686$ |
| Apr. 9 | $\xi_p = -\cdot0141$ | $\eta_p = -\cdot1477$ |
| | $\xi_t = +\cdot0072$ | $\eta_t = +\cdot0207$ |
| | $\xi_t - \xi_p = +\cdot0217$ | $\eta_t - \eta_p = +\cdot1684$ |

the absolute values of the coordinates being obtained from the measures connecting the points with Mösting A, those of the differences from measures connecting the points directly. The final values obtained from these are :—

| | |
|---|---|
| $\xi_p = -\cdot0142 \pm \cdot00007$ | $\eta_p = -\cdot1479 \pm \cdot00007$ |
| $\xi_t = +\cdot0072 \pm \cdot00007$ | $\eta_t = +\cdot0205 \pm \cdot00007$ |

Professor Barnard writes : "The measures were made with the utmost care that could be exercised under the conditions," but "the objects are so large, especially with a big telescope, that considerable discordances might be expected in the measures from difference of illumination, position, &c."

"On April 7 the three craters were approximately measured. The seeing was very poor (on the 9th also), and the crater form was not well enough seen to make exact measures, but these will not be far out. They will give some idea of the size of the spot one has to bisect in making the measures.

| | |
|---|---|
| Apparent diameter of Mösting A | $6''\cdot38$ |
| ,, ,, Ptolemaus A | $4\cdot66$ |
| ,, ,, Triesnecker B | $2\cdot94$ " |

The position-angles of the measured diameters were such that these distances require to be multiplied by 1·0270, 1·0262, 1·0058 respectively in order to obtain the corresponding maximum diameters. The Moon's occultation radius at the time was $908''\cdot0$, and hence, remembering that the formations were nearer

than the radius which subtends this angle, the real diameters are found to be :—

| | | | | |
|---|---|---|---|---|
| Mösting A | ·00718 | of Moon's radius | =7·77 | miles |
| Ptolemaus A | ·00524 | „ „ | =5·67 | „ |
| Triesnecker B | ·00325 | „ „ | =3·51 | „ |

One of my reasons for asking for measures of these particular points was that, their positions being known, I should be able to find the centre of the disc on any given photograph on which they appear without encountering the difficulties involved in measuring from the limb. A second reason was that a comparison of my own results with Professor Barnard's would show whether my measures are affected by any serious systematic error.

In my previous paper (*ante*, p. 181) I give the results of five nights' measures of Ptolemaus A, of which the means are :—

$$\xi_p = -\cdot 0139 \qquad \eta_p = -\cdot 1477$$

I have also taken the following :—

| | | | |
|---|---|---|---|
| 1900 Feb. | 8 | $\xi_p = -\cdot 0139$ | $\eta_p = -\cdot 1472$ |
| 1899 Nov. | 18 | $\xi_t = +\cdot 0068$ | $\eta_t = +\cdot 0205$ |
| Dec. | 13 | $+\cdot 0076$ | $+\cdot 0203$ |
| | 15 | $+\cdot 0079$ | $+\cdot 0206$ |
| 1900 Feb. | 8 | $+\cdot 0073$ | $+\cdot 0204$ |
| | 8 | $\xi_t - \xi_p = +\cdot 0210$ | $\eta_t - \eta_p = +\cdot 1687$ |
| | 9 | $+\cdot 0213$ | $+\cdot 1685$ |

The final result from all my measures being

$$\xi_p = -\cdot 0139 \pm \cdot 00008 \qquad \eta_p = -\cdot 1478 \pm \cdot 00008$$
$$\xi_t = +\cdot 0073 \pm \cdot 00009 \qquad \eta_t = +\cdot 0206 \pm \cdot 00010$$

My individual measures are, as was to be expected, more discordant than those of Professor Barnard, but on comparing my final values with his it appears that in only one case is there a difference of more than ·0001, *i.e.* of more than $0''\cdot 1$, and this coordinate, for which the difference is $0''\cdot 3$, is the one in which the two causes noticed by Professor Barnard, viz. size of objects measured and changes of illumination, combine to produce their greatest effect.

In order to test the existence of systematic error more closely, I have, from these places, computed the values of the lines and angles actually measured as they would appear under mean libration. The following are the results from Professor Barnard's measures :—

*Lengths of Lines.*

MP ·1194 , MT ·1234 , PT ·1698

*Inclinations to Axis of ξ.*

MP 129°·39 , MT 38°·06 , PT 82°·76

From my measures :—

*Lengths of Lines.*

MP ·1195 , MT ·1236 , PT ·1697

*Inclinations to Axis of ξ.*

MP 129°·54 , MT 38°·07 , PT 82°·82

This comparison seems to justify the conclusion that my measures are subject to no serious systematic error, and to support my claim that the positions given in my previous paper are of a higher order of accuracy than those found by measuring from the limb.

These two points, Ptolemaus A and Triesnecker B, are now—next to Mösting A—the best known positions on the Moon's surface.

Professor Barnard says in the letter which accompanies his measures that he had intended to give three nights to the work, but that he found it too trying to his eyesight. The fact that under these conditions he did not stop after the first night renders the extent of my obligation to him a very great one ; and I am sure that all will concur in the earnest hope that what he has so kindly done may not have impaired that well-known sensitiveness of retina of which his discoveries have given so many proofs.

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*On Planning Photographic Observations of Eros.* Arthur R. Hinks, M.A.

1. In considering a scheme of photographic operations for the coming opposition of *Eros* the following points suggest themselves :—The planet is so faint, and its motion is so rapid, that it will be necessary with all instruments, except perhaps the largest, to follow on the planet and let the stars trail. In September and October, and again in January, the necessary exposures will run into minutes, especially since, according to Professor Pickering, the planet is photographically about $0^{m}\cdot6$ fainter than the visual magnitude.

Even at its brightest the planet will be a difficult object to follow visually in the guiding telescope ; and when it is fainter it will probably be impossible to guide upon it. Moreover, in some modern instruments the guiding telescope is dispensed with, and a star just off the edge of the plate is kept bisected in a guiding eyepiece. In such a case it is, of course, impossible to guide directly on the planet, and it will be necessary to give the plate a continuous movement whose direction and velocity are calculated beforehand.

It looks, then, as if it will be necessary in most cases to substitute guiding by calculated displacements for visual following. To meet such a contingency the screws which move the plate-holder of the Cambridge Equatorial along rectangular slides on the breech-piece of the telescope have been provided with divided heads. It would be possible to get the requisite motion of the plate by turning the heads through calculated small amounts at successive intervals of a few seconds. But to work the two slides simultaneously in this way would be too complicated. It seems to me that the better plan will be to get the trail in R.A. by adding weights to or removing them from the dish of the pendulum which controls the driving clock, after the plan described by Dr. Rambaut ("On the Inequality in the Apparent Movement of Stars due to Refraction, and a Method of allowing for it in Astronomical Photography," *Monthly Notices*, 1896, vol. lvii. p. 50). The observer will then be free to concentrate his attention on giving the motion to the declination slide.

2. In calculating the rates of displacement required we must take account of—

*a*. The proper motion of the planet.

*b*. The variation of the refraction with the hour-angle.

*c*. The variation of the parallactic displacement with the hour-angle.

*d*. The effect of any error in the adjustment of the instrumental to the true pole.

2*a*. The proper motion of the planet is given in the ephemeris by Dr. Millosevich in the *Berliner Jahrbuch* for 1902. The losing rate to be given to the clock is equal to the rate of increase of the planet's R.A.

2*b*. Let $\phi$ be the astronomical latitude,
$\delta$ the declination of the planet,
$h$ its hour-angle measured west,
and let $\tan\theta = \cot\phi\cos h$.

It is easily shown that the trail in R.A. is equivalent to a losing rate of the clock of

$$24^{s}\cdot 5\,\frac{\sin\theta\cos\theta}{\sin^2(\delta+\theta)}\,(\tan\delta+\cot\phi\sec h)\text{ per day.}$$

The rate of trail in declination is equivalent to a motion of

$$+15''\cdot 3\cot\phi\sin h\operatorname{cosec}^2\overline{\delta+\theta}\cos^2\theta\text{ per hour.}$$

(For proof of the latter result see a paper by the writer in *Monthly Notices*, 1898, vol. lviii. p. 430.)

2*c*. Let $\phi_0$ be the geocentric latitude,
$\Delta$ the distance of the planet from the Earth.

The rate of trail in R.A. is equivalent to a gaining rate of

$$3^{s}\cdot69 \times 1/\Delta \times \cos\phi \cos\phi_0 \sec\delta \cos h \text{ per day},$$

and the rate of increase of declination is

$$-2''\cdot3 \times 1/\Delta \times \cos\phi_0 \cos\phi \sin\delta \sin h \text{ per hour}.$$

2*d*. It has been shown by the writer (*loc. cit.* pp. 429, 433) that if the instrumental is displaced from the true pole by 100″ in hour-angle H, the correction required in R.A. is equivalent to a gaining rate of the clock of

$$41^{s}\cdot9 \cos(h-H) \tan\delta \text{ per day},$$

and the apparent rate of increase of declination is

$$-26''\cdot2 \sin(h-H) \text{ per hour}.$$

The rates for other displacements are proportional.

3. Take as an example the case of photographing the planet at Cambridge on September 17, $21^{h}$ W. of the meridian.

| | Clock rate. | Decl. rate. |
|---|---|---|
| | s | ″ |
| Proper motion ... ... | −45·0 | +57·1 |
| Refraction ... ... ... | −22·2 | − 7·5 |
| Parallax ... ... ... | + 1·8 | + 0·6 |
| Error of pole (say 50″ in $13^{h}$ west) | − 17·0 | −11·4 |
| | −82·4 per day. | +38·8 per hour. |

The photographic magnitude on this day will be about $12\frac{1}{2}^{m}$. Suppose that it requires $10^{m}$ exposure. The displacement due to other causes than proper motion amounts to about $4\frac{1}{2}''$ during that time; and unless they are taken into account the planet will not be photographed, even if its proper motion of 1″ per minute is allowed for.

4. It is clear that to deal with *Eros* successfully requires that the instrumental adjustment shall be of great accuracy. In the case of our example, if we can rate our control pendulum perfectly, we shall have to deal with a rate in declination of 0″·65 per minute. With a half-millimetre screw and head divided into 100 parts, we shall be able to follow by turning the head three-tenths of a division every five seconds.

With the standard astrographic equatorial it would be impossible to guide visually upon a planet of magnitude $12\frac{1}{2}$. It seems that it might be well to provide such an instrument with

a slide and screw motion of the plate-holder in declination such as I have described.

The accompanying plate (Plate 17) has been drawn to help in planning the night's work. It shows for Cambridge (lat. 52° 13′) the zenith distance of the planet for every hour of the night at intervals of fourteen days, with the corresponding parallax factor; the computed photometric magnitudes, according to Pickering; the proper motion of the planet (on the scale side of one square=2″ per minute), and the limits to the observations imposed by daylight.

*Cambridge Observatory:*
1900 *May* 9.

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*Observations of the Spots and Markings on the Planet Jupiter, made at the Dearborn Observatory of North-Western University, Evanston, U.S.A.* By G. W. Hough, Director.

(*Communicated by the Secretaries.*)

The spots and markings on the surface of the planet *Jupiter*, dealt with in the present paper, have been located by means of the micrometer, and, with a few exceptions, a magnifying power of 400 has been used. If a lower power, viz. 190, is employed, the finer details cannot be well seen.

Hitherto observers have confined their observations almost entirely to displacement in longitude or rotation period. I believe that displacements in both longitude and latitude are essential for the correct interpretation of the phenomena seen on the surface.

The position of a spot or marking is determined when it is wholly on the disc, but preferably near the central meridian.

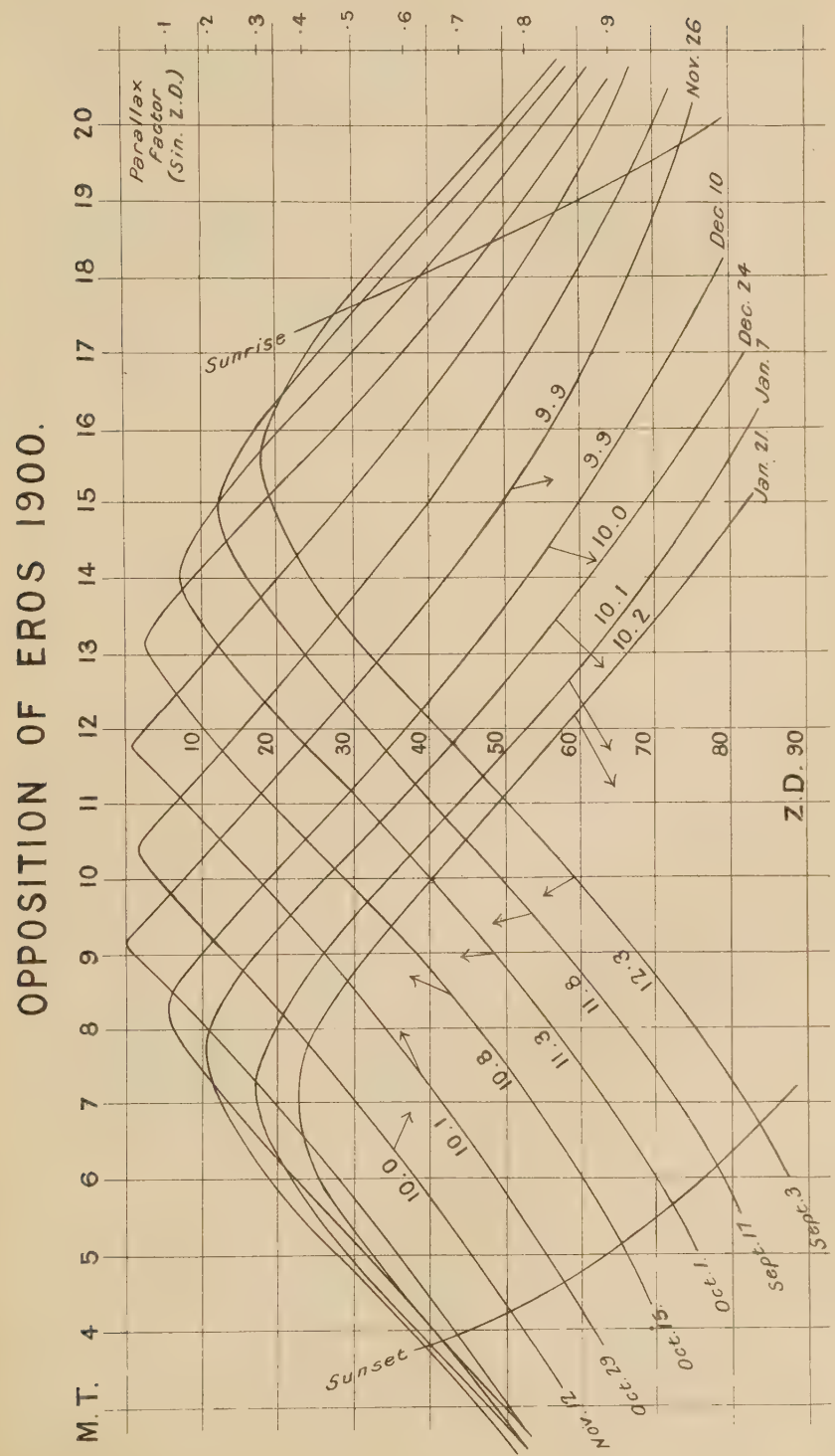
An observation for position usually consists of three measures from each limb of the planet. The measures are referred to both limbs in order to eliminate the error due to irradiation, or, what is of great importance, the enlargement of the disc due to imperfect definition.

T=time of passage over the central meridian of the luminous disc, not corrected for defective illumination. The time is that of the 90th meridian, or 6 hours slow of Greenwich M.T.

$\beta$=distance from the apparent equator of the disc. After applying the correction for the elevation of the Earth above *Jupiter's* equator, the distance north or south of the equator is designated reduced latitude.

L=length of chord on middle of disc.

In the determination of rotation period the observations have been corrected for longitude of equinox, aberration time, annual parallax, and defective illumination. With the exception of the


OPPOSITION OF EROS 1900.
M.T.
Z.D.
Parallax Factor (Sin. Z.D.)
Sunrise
Sunset
Nov. 26
Dec. 10
Dec. 24
Jan. 7
Jan. 21
Sept. 3
Sept. 11
Oct. 1
Oct. 15
Oct. 29
Nov. 12
9.9
9.9
10.0
10.1
10.2
11.3
11.3
11.3
10.8
10.1
10.0

longitude of equinox, all the other corrections have been derived from Marth-Crommelin ephemerides.

All measures are reduced to mean distance.

### *The Great Red Spot.*

The great Red Spot remained faint and indistinct for the greater portion of the time covered by these observations. Near the time of opposition, however, the outline could be traced, and the spot appeared of a greenish tint. In the absence of the depression in the equatorial belt, the spot long ago would have escaped notice in most telescopes.

The rotation period for the great Red Spot is still slowly increasing.

| Date. | | h m | Rotation. s |
|---|---|---|---|
| 1896 | | 9 55 | 41·42 |
| 1897 | | „ | 41·32 |
| 1898 | | „ | 41·62 |
| 1899 | | „ | 41·76 |
| Interval. | Days. | | |
| 5600 | 6000 | „ | 41·38 |
| 6000 | 6400 | „ | 41·32 |
| 6400 | 6800 | „ | 41·54 |
| 6800 | 7200 | „ | 41·68 |

The rotation periods for the 400-day intervals were computed by using normal places for each opposition.

The probable error on the rotation period for the 400-day interval is $\pm 0^{s}\cdot04$ sec., but owing to the faintness of the object during recent years, there may be considerable systematic error in locating the centre of the spot.

The 400-day intervals are counted from 1879 September 25.

The observations for each opposition, usually, could be better satisfied by making the rotation period a function of the time; but during recent years the spot has been so faint that observations of a high degree of precision were impossible. The residuals in the column O—E show, however, that at no time has there been any abrupt change in the rate of motion of the spot.

The great Red Spot is not stationary in latitude.

Its mean position 1879 to 1899 is:

Reduced Latitude $-6''\cdot27 = 18°\cdot9$ Jovicentric Latitude.

The results for the last four years are as follows:

| Year. | Mean Day. | Reduced Latitude. | |
|---|---|---|---|
| 1896 | 6019 | $-5''\cdot64$ | 17 obs. |
| 1897 | 6395 | $-6\cdot07$ | 14 „ |
| 1898 | 6786 | $-6\cdot14$ | 15 „ |
| 1899 | 7126 | $-6\cdot23$ | 4 „ |

The greatest and least mean values for the latitude during any opposition since 1879 are as follows :

| Year. | Mean Day. | Reduced Latitude. | |
|---|---|---|---|
| 1886 | 2385 | −7″·21 | 9 obs. |
| 1893 | 5194 | −5·53 | 8 „ |

These numbers indicate that the spot has drifted in latitude about 4,000 miles.

Owing to the faintness of the spot during the past four years, the measures of length are few, and should be regarded as approximate.

The mean of six nights 1897–98 is 11″·46. During the earlier years, when the outline of the spot was well defined, the adopted value for the length was 11″·61 or 37°·2. It seems probable, therefore, that the spot has not materially changed in size during the past twenty years.

The following table gives the observations in detail, and the comparison with an Ephemeris. As might be expected, the residuals, Obs.-Eph. are somewhat greater than when the spot was well defined.

*The Great Red Spot.* R = 9ʰ 55ᵐ 41ˢ·42.

| Date. | Days. | T | O−E. | β |
|---|---|---|---|---|
| 1895. | | h m | m | ″ |
| Nov. 2 | 0 | 18 21·4 | −0·8 | ... |
| Dec. 15 | 43 | 8 53·0 | −1·2 | −5·95 |
| 31 | 59 | 12 01·4 | −1·6 | ... |
| 1896. | | | | |
| Jan. 29 | 88 | 10 55·6 | +0·7 | ... |
| Feb. 5 | 95 | 11 39·8 | −0·4 | 5·81 |
| 8 | 98 | 9 11·2 | +1·4 | 5·46 |
| 13 | 103 | 8 14·9 | −2·4 | 5·96 |
| 27 | 117 | 9 49·0 | −0·6 | ... |
| 28 | 118 | 5 39·2 | −1·6 | 6·38 |
| Mar. 1 | 120 | 7 20·9 | +1·6 | 5·80 |
| 3 | 122 | 8 57·6 | +0·8 | 5·73 |
| 8 | 127 | 8 05·6 | −0·4 | 5·59 |
| 20 | 139 | 7 58·4 | −3·6 | 5·88 |
| 23 | 142 | 5 31·5 | −0·6 | 6·34 |
| 27 | 146 | 8 50·7 | +1·1 | ... |
| Apr. 1 | 151 | 8 00·7 | +1·9 | 5·67 |
| 3 | 153 | 9 39·5 | +1·8 | 5·73 |
| 6 | 156 | 7 12·7 | +4·6 | 5·53 |
| 27 | 177 | 9 34·4 | +0·9 | ... |
| 30 | 180 | 7 06·7 | +2·5 | 5·70 |
| May 2 | 182 | 8 40·6 | −2·7 | 5·84 |
| 26 | 206 | 8 37·7 | −3·7 | 5·15 |
| June 5 | 216 | 7 02·0 | −1·9 | 6·04 |

*The Great Red Spot.* R = 9h 55m 41s·32.

| Date 1897. | Days. | T. h m | O−E. m | β ″ | L. ″ |
|---|---|---|---|---|---|
| Jan. 18 | 0 | 10 15 est. | −2·0 | ... | ... |
| 20 | 2 | 11 56·2 | +1·4 | +6·33 | 11·92 |
| 30 | 12 | 10 10·2 | +0·8 | 5·65 | ... |
| Feb. 13 | 26 | 11 38·4 | −0·8 | 5·34 | ... |
| 18 | 31 | 10 44·9 | −1·4 | 6·10 | ... |
| Mar. 3 | 44 | 6 34·2 | −0·2 | 5·54 | ... |
| 9 | 50 | 11 27·1 | +2·1 | ... | ... |
| 10 | 51 | 7 20·2 | +3·8 | 5·73 | ... |
| 12 | 53 | 8 57·5 | +2·8 | 5·93 | ... |
| 15 | 56 | 6 25·1 | +1·1 | 5·60 | ... |
| Apr. 17 | 89 | 8 33·4 | −4·8 | 5·43 | ... |
| 24 | 96 | 9 24·8 | −0·5 | 5·88 | 10·31 |
| May 18 | 120 | 9 19·9 | −0·4 | 5·07 | ... |
| 28 | 130 | 7 35·3 | −4·0 | ... | ... |
| June 21 | 154 | 7 40·0 | +3·3 | 5·93 | ... |

*The Great Red Spot.* R = 9h 55m 41s·62.

| Date. 1897. | Days. | T. h m | O−E. m | β. ″ | L. ″ |
|---|---|---|---|---|---|
| Dec. 6 | 0 | 17 14·7 | +0·0 | ... | ... |
| 1898. | | | | | |
| Jan. 2 | 27 | 14 37·5 | +2·2 | ... | ... |
| 13 | 38 | 18 39·9 | +0·7 | −5·05 | ... |
| Mar. 4 | 88 | 9 55·9 | +1·5 | 5·67 | ... |
| 23 | 107 | 10 36·6 | +4·5 | 5·46 | ... |
| 28 | 112 | 9 39·8 | +0·5 | 5·27 | ... |
| Apr. 2 | 117 | 8 46·6 | −0·2 | 4·79 | ... |
| 5 | 120 | 6 15·1 | −1·0 | ... | ... |
| 7 | 122 | 7 55·4 | −1·1 | 5·59 | ... |
| 9 | 124 | 9 31·0 | −1·5 | 5·90 | 10·30 |
| 16 | 131 | 10 18·7 | +0·5 | ... | ... |
| 28 | 143 | 10 10·0 | −2·4 | 4·71 | 11·31 |
| May 3 | 148 | 9 16·5 | −4·0 | 5·80 | 11·79 |
| 8 | 153 | 8 24·6 | −4·2 | 5·29 | 12·45 |
| June 1 | 177 | 8 23·0 | +1·7 | 5·01 | ... |
| 3 | 179 | 10 00·2 | +0·1 | 5·49 | ... |
| 8 | 184 | 9 11·9 | +2·6 | 4·57 | ... |
| 13 | 189 | 8 16·8 | −1·7 | 5·20 | ... |
| 25 | 201 | 8 12·9 | −3·8 | ... | ... |
| 27 | 203 | 9 57·6 | +2·0 | 6·15 | ... |
| July 7 | 213 | 8 15·6 | +0·8 | ... | ... |
| 12 | 218 | 7 23·8 | −0·8 | ... | ... |
| 14 | 220 | 9 01·4 | −2·1 | ... | ... |

*The Great Red Spot.* R = $9^h\ 55^m\ 41^s.76$.

| Date. | Days. | T. | O−E. | β |
|---|---|---|---|---|
| 1898. | | h m | m | ″ |
| Dec. 10 | 0 | 18 02·5 | +3·6 | ... |
| 1899. | | | | |
| Jan. 15 | 36 | 17 47·7 | −0·8 | ... |
| Feb. 28 | 80 | 14 09·1 | −1·5 | −5·84 |
| Mar. 19 | 99 | 14 50·2 | +0·2 | 5·03 |
| Apr. 8 | 119 | 11 18·6 | −0·2 | 5·03 |
| 23 | 134 | 8 41·1 | +0·5 | ... |
| 25 | 136 | 10 18·7 | −0·2 | ... |
| May 2 | 143 | 11 02·7 | −1·3 | 4·68 |
| 9 | 150 | 11 44·7 | −1·6 | ... |
| 22 | 163 | 7 36·7 | +2·0 | ... |
| 26 | 167 | 10 54·0 | +2·8 | ... |
| 27 | 168 | 6 41·6 | −0·9 | ... |
| 29 | 170 | 8 19·6 | −1·3 | ... |
| 31 | 172 | 9 59·0 | −0·5 | ... |
| June 3 | 175 | 7 31·1 | +1·8 | ... |
| 5 | 177 | 9 08·5 | +0·7 | ... |
| 7 | 179 | 10 45·5 | +0·2 | ... |
| 9 | 181 | 12 29·8 | +5·1 | ... |
| 12 | 184 | 9 56·2 | +1·4 | ... |
| 19 | 191 | 10 41·6 | −0·2 | ... |
| 24 | 196 | 9 51·1 | +0·3 | ... |
| 29 | 201 | 8 57·6 | −2·2 | ... |
| July 1 | 203 | 10 36·3 | −2·4 | ... |
| 6 | 208 | 9 42·0 | −5·8 | ... |
| 11 | 213 | 8 56·1 | −0·9 | ... |
| 28 | 230 | 8 03·8 | −0·7 | ... |
| Aug. 9 | 242 | 8 06·2 | +3·3 | ... |

*Black and White Spots.*

The following table gives the date; longitude at the time of the first observation from Marth-Crommelin Meridian II.; interval in days between the first and last observation; the reduced latitude and the rotation period :—

| Date. | Long. | Days. | Red. Lat. | Rotation P. |
|---|---|---|---|---|
| | h m | | ″ | h m s |
| 1895 Oct. 29 | +2 17 | 156 | +8·39 | 9 55 60·48 |
| 1897 Apr. 9 | +8 10 | 46 | +8·18 | 59·7 |
| 1898 Mar. 13 | +7 15 | 58 | +8·05 | 52·1 |
| 1895 Oct. 18 | +6 19 | 179 | +4·45 | 31·8 |

| Date. | Long. | Days. | Red. Lat. | Rotation P. |
|---|---|---|---|---|
| | h m | | ″ | h m s |
| 1895 Oct. 18 | +7 52 | 199 | +4·66 | 9 55 34·2 |
| 1897 Dec. 26 | +0 24 | 191 | +4·34 | 27·2 |
| 1898 Mar. 1 | +8 54 | 132 | +4·36 | 26·6 |
| 1898 Apr. 1 | +7 17 | 74 | +4·41 | 26·6 |
| 1899 Mar. 28 | +5 26 | 63 | +5·01 | 20·8 |
| 1899 Apr. 3 | +9 24 | 96 | +4·89 | 32·3 |
| 1899 May 26 | +0 03 | 29 | +4·9 | 34·2 |
| 1897 Feb. 17 | +4 07 | 31 | +4·17 | 47·6 |
| 1899 May 27 | +1 52 | 7 | +3·83 | 20·7 |
| 1897 Jan. 9 | +4 29 | 104 | +3·11 | 48·6 |
| 1897 Jan. 18 | +2 19 | 140 | +1·49 | 47·9 |
| 1897 Feb. 20 | +6 10 | 62 | +2·29 | 09·1 |
| 1897 Feb. 27 | +5 19 | 100 | +1·48 | 09·2 |
| | *Meridian I.* | | | |
| 1899 Apr. 4 | +6 20 | 80 | −2·56 | 9 50 29·9 |
| 1899 May 9 | +6 58 | 34 | −1·41 | 23·9 |

An inspection of the above table shows a variation of fifty-one seconds in the length of the rotation period $9^h\ 55^m+$.

The spots observed in reduced latitude $+8''$, during the three successive oppositions 1895 to 1898, give the longest rotation periods I have observed, covering a long interval of time. An acceleration in the rotation period at this latitude is clearly shown during the three years. Some of the spots observed in 1897 bring the rotation period $9^h\ 55^m+$ within five degrees of the equator.

The observations which follow indicate the kind of spot observed, latitude, length, and comparison with an Ephemeris.

*Black Spots $B_3$.* $R = 9^h\ 56^m\ 00^s{\cdot}48$.

| Date. | Days. | T | O−E. | β | L. |
|---|---|---|---|---|---|
| 1895. | | h m | m | ″ | ″ |
| Oct. 29 | 0 | 17 08·7 | +1·0 | +7·87 | ... |
| 1896. | | | | | |
| Feb. 21 | 115 | [8 19·1] | −5·9 | ... | ... |
| Mar. 2 | 125 | 6 46·9 | −2·0 | ... | ... |
| 4 | 127 | 8 28·7 | +0·0 | +8·45 | 4·23 |
| 16 | 139 | 8 33·6 | −0·1 | +8·29 | 3·48 |
| 23 | 146 | 9 27·2 | +1·0 | ... | ... |
| April 2 | 156 | 7 50·5 | −1·9 | ... | ... |

Mean reduced lat. $+8''{\cdot}39$. 3 obs.

Length ... ... $3''{\cdot}85$. 2 obs.

R = 9h 55m 59s·7.

| Date. 1897. | Days. | T. h m | O—E. m | β ″ | L. ″ |
|---|---|---|---|---|---|
| April 9 | 0 | 9 45·4 | −4·6 | +8·40 | 6·90 |
| 14 | 5 | 9 01·8 | −0·6 | 8·44 | ... |
| 17 | 8 | 6 35·1 | +0·5 | 8·51 | 6·51 |
| 19 | 10 | 8 15·8 | +1·0 | ... | ... |
| 24 | 15 | 7 32·7 | +5·4 | 8·69 | 6·40 |
| 26 | 17 | 9 05·6 | −1·9 | ... | ... |
| May 13 | 34 | 8 24·7 | −2·0 | 8·27 | ... |
| 15 | 36 | 10 09·8 | +2·9 | 8·64 | ... |
| 25 | 46 | 8 32·6 | −0·6 | ... | ... |

Mean reduced lat. +8″·18. 6 obs.

Length ... ... 6″·60. 3 obs.

R = 9h 55m 52s·1.

| Date. 1898. | Days. | T. h m | O—E. m | β ″ | L. ″ |
|---|---|---|---|---|---|
| Mar. 13 | 0 | 8 55·9 | +0·0 | +9·48 | 5·03 |
| 30 | 17 | 8 03·4 | +0·5 | +8·50 | ... |
| April 1 | 19 | 9 40·5 | −1·4 | 8·90 | 5·41 |
| 6 | 24 | 8 50·3 | −1·2 | 8·36 | 5·22 |
| 11 | 29 | 8 00·2 | −0·9 | 8·65 | 4·82 |
| May 7 | 55 | 9 40·2 | +1·1 | 8·81 | ... |
| 10 | 58 | 7 10·5 | +0·1 | 8·94 | ... |

Mean reduced lat. +8″·05. 7 obs.

Length ... ... 5″·12. 4 obs.

*Black Spot a.* R = 9h 55m 31s·8.

| Date. 1895. | Days. | T. h m | O—E. m | β ″ |
|---|---|---|---|---|
| Oct. 18 | 0 | 17 07·0 | +2·6 | ... |
| Nov. 4 | 17 | 16 00·9 | −0·7 | +4·13 |
| Dec. 9 | 52 | 9 44·5 | +1·6 | +4·50 |
| 21 | 64 | 9 33·0 | +2·0 | +4·11 |
| 26 | 69 | 8 37·6 | +0·7 | ... |
| 30 | 73 | 11 50·0 | −0·9 | +3·97 |
| 1896. | | | | |
| Jan. 9 | 83 | 9 58·5 | −3·0 | +4·06 |
| 11 | 85 | 11 36·4 | −2·3 | ... |
| 14 | 88 | 9 04·7 | −1·6 | ... |
| 29 | 103 | 6 25·4 | +3·2 | +4·73 |
| Feb. 5 | 110 | 7 06·5 | +1·3 | +4·72 |
| 10 | 115 | 6 11·0 | +0·2 | ... |

| Date. 1896. | Days. | T. h m | O−E. m | β ″ |
|---|---|---|---|---|
| Mar. 16 | 150 | 9 42·6 | −7·2 | +4·14 |
| 19 | 153 | 7 19·2 | +0·2 | ... |
| April 2 | 167 | 8 45·1 | −3·9 | ... |
| 14 | 179 | 8 43·7 | +1·9 | ... |

Mean reduced lat. +4″·45. 8 obs.
Length ... ... 2″·19. 3 obs.

*Black Spot b.* R = $9^h\ 55^m\ 34^s·2$.

| Date. 1895. | Days. | T. h m | O−E. m | β ″ |
|---|---|---|---|---|
| Oct. 18 | 0 | 18 40·3 | −0·5 | ... |
| Nov. 4 | 17 | 17 36·6 | −2·9 | ... |
| Dec. 9 | 52 | 11 28·5 | +4·2 | ... |
| 21 | 64 | 11 14·6 | +1·0 | ... |
| 26 | 69 | 10 23·4 | +4·0 | ... |
| 31 | 74 | 9 31·2 | +5·9 | ... |
| 1896. Jan. 2 | 76 | 11 05·5 | +2·5 | ... |
| 10 | 84 | 7 44·9 | +8·3 | ... |
| 14 | 88 | 10 45·4 | +5·9 | ... |
| 20 | 94 | 5 51·6 | +3·3 | +4·61 |
| 29 | 103 | 8 10·7 | +1·8 | ... |
| Feb. 5 | 110 | 8 53·4 | +1·1 | ... |
| 8 | 113 | 6 22·5 | +1·6 | +4·07 |
| 10 | 115 | 8 00·1 | +1·6 | ... |
| 27 | 132 | 7 02·4 | +5·0 | +4·27 |
| Mar. 19 | 153 | 9 05·0 | −7·1 | +4·30 |
| April 2 | 167 | 10 35·3 | −8·4 | +4·41 |
| 15 | 180 | 6 28·8 | −0·2 | +4·84 |
| 22 | 187 | 7 10·9 | −4·7 | +4·69 |
| 27 | 192 | 6 19·2 | −2·5 | +5·05 |
| 29 | 194 | 7 54·9 | −5·3 | +4·18 |
| May 4 | 199 | 7 06·5 | −2·0 | ... |

Mean reduced lat. +4″·66. 9 obs.
Length ... ... 1″·88. 2 obs.

The spot was nearly round, and appeared like the shadow of a satellite.

*Black Spot a.* R = $9^h\ 55^m\ 27^s{\cdot}2$.

| Date. 1897. | Days. | T. h m | O—E. m | β ″ | L. ″ |
|---|---|---|---|---|---|
| Dec. 26 | 0 | [17 35] est. | +0·3 | ... | ... |
| 1898. | | | | | |
| Feb. 13 | 49 | 12 37·7 | +3·6 | +4·24 | ... |
| Mar. 7 | 71 | 10 26·2 | −2·5 | 4·89 | 5·59 |
| 17 | 81 | 8 38·3 | +1·0 | 5·01 | 6·06 |
| 24 | 88 | 9 17·5 | −1·0 | 5·48 | 7·16 |
| 29 | 93 | 8 21·6 | −2·3 | 5·16 | 6·78 |
| 31 | 95 | 9 57·3 | −3·5 | 5·77 | 6·13 |
| April 5 | 100 | 9 01·4 | −5·1 | 5·23 | 7·17 |
| 7 | 102 | 10 41·6 | −1·7 | ... | 8·45 |
| 10 | 105 | 8 07·1 | −3·7 | ... | ... |
| 15 | 110 | 7 16·7 | +1·0 | 5·52 | ... |
| 24 | 119 | 9 30·7 | −1·9 | ... | ... |
| 29 | 124 | 8 37·2 | −0·8 | 5·26 | 8·00 |
| May 13 | 138 | 10 04·8 | +1·3 | ... | ... |
| 23 | 148 | 8 18·3 | +3·1 | 5·05 | 7·30 |
| 30 | 155 | 9 00·8 | +1·9 | 4·42 | 6·96 |
| June 4 | 160 | 8 08·0 | +2·9 | 5·26 | 7·94 |
| 28 | 184 | [7 54·9] | (+8·3) | 5·15 | ... |
| July 5 | 191 | 8 29·2 | −2·3 | 5·79 | ... |

Mean reduced lat. +4″·34. 14 obs.
Length ... ... 7″·05. 11 obs.

*Black Spot b.* R = $9^h\ 55^m\ 26^s{\cdot}6$.

| Date. 1898. | Days. | T. h m | O—E. m | β ″ | L. ″ |
|---|---|---|---|---|---|
| Mar. 1 | 0 | [10 43] est | [+9·1] | ... | ... |
| 13 | 12 | 10 18·3 | −1·1 | +4·85 | 3·45 |
| 23 | 22 | 8 32·4 | +4·5 | 5·38 | 4·23 |
| 30 | 29 | 9 06·9 | −2·2 | 5·63 | 5·60 |
| Apr. 1 | 31 | 10 48·1 | +2·2 | 5·25 | 5·80 |
| 11 | 41 | 8 52·2 | +2·2 | 5·41 | 6·50 |
| 16 | 46 | 7 55·8 | +0·2 | ... | ... |
| 28 | 58 | 7 42·5 | −2·0 | ... | ... |
| May 3 | 63 | 6 48·8 | −2·9 | ... | ... |
| 5 | 65 | 8 26·1 | −2·8 | ... | ... |
| 7 | 67 | 10 01·6 | −4·7 | ... | ... |
| 10 | 70 | 7 36·5 | +2·1 | 5·18 | ... |
| 12 | 72 | 9 12·8 | +1·3 | ... | ... |
| 17 | 77 | 8 15·1 | −2·1 | ... | ... |
| June 17 | 108 | 8 39·8 | −0·6 | ... | ... |
| July 6 | 127 | 9 13·9 | −2·0 | ... | ... |
| 11 | 132 | 8 21·5 | −1·3 | 4·75 | ... |

Mean reduced lat. +4″·36. 7 obs.
Length ... ... 5″·12. 5 obs.

*Black Spot.* R = 9h 55m 48s·6.

| Date. 1897. | Days. | T. h m | O—E. m | β ″ |
|---|---|---|---|---|
| Jan. 9 | 0 | 11 56·3 | +0·0 | +3·4 est. |
| Feb. 24 | 46 | 10 00·3 | −1·2 | +3·54 |
| Mar. 20 | 70 | 9 54·9 | +0·0 | ... |
| Apr. 23 | 104 | 8 13·0 | +1·2 | ... |

Reduced lat. +3″·11.

*Black Spot.* R = 9h 55m 47s·6.

| 1897. | | h m | m | ″ |
|---|---|---|---|---|
| Feb. 17 | 0 | 8 40 est. | +0·0 | ... |
| 27 | 10 | 6 55·2 | −2·3 | +4·60 |
| Mar. 20 | 31 | 9 19·9 | +0·0 | ... |

Reduced lat. +4″·17.

*White Spot.* R = 9h 50m 29s·9.

| 1899. | | h m | m | ″ |
|---|---|---|---|---|
| Apr. 4 | 0 | 11 24·1 | +0·0 | −0·93 |
| May 11 | 37 | 9 04·5 | +3·3 | ... |
| June 21 | 78 | 9 10·0 | +0·8 | −1·74 |
| 23 | 80 | 10 22·0 | +0·1 | −1·61 |

Mean reduced lat. −2″·56. 3 obs.

*White Spot.* R = 9h 50m 23s·9.

| 1899. | | h m | m | ″ |
|---|---|---|---|---|
| May 9 | 0 | 8 28·2 | +3·2 | −0·23 |
| 11 | 2 | 9 32·0 | −3·8 | −0·38 |
| June 12 | 34 | 8 52·3 | +0·0 | −0·41 |

Mean reduced lat. −1″·41. 3 obs.

*Black Spot.* R = 9h 55m 09s·2.

| 1897. | | h m | m | ″ |
|---|---|---|---|---|
| Feb. 27 | 0 | 8 06·2 | +1·0 | ... |
| Mar. 20 | 21 | 9 54·9 | −0·1 | ... |
| Apr. 25 | 57 | 8 53·1 | −0·8 | +1·78 |
| May 4 | 66 | 11 09·5 | +0·6 | +1·86 |

Reduced lat. +1″·48. 2 obs.

*Black Spot.* R = $9^h\ 55^m\ 09^s.1$.

| Date. 1897. | Days. | T. h m | O—R. m | β ″ |
|---|---|---|---|---|
| Feb. 20 | 0 | 8 12·1 | +2·1 | ... |
| 22 | 2 | 9 44·1 | −1·6 | ... |
| 27 | 7 | 8 45·9 | −0·3 | ... |
| Apr. 23 | 62 | 8 13·0 | −0·1 | +2·62 |

Reduced lat. +2″·29.

*Black Spot.* R = $9^h\ 55^m\ 47^s.9$.

| 1897. | | | | | |
|---|---|---|---|---|---|
| Jan. | 18 | 0 | 12 10·0 | +0·0 | ... |
| Feb. | 15 | 15 | 9 34·0 | −1·6 | ... |
| | 24 | 37 | 7 52·4 | +4·4 | ... |
| Apr. | 25 | 97 | 7 28·5 | −7·3 | +1·78 |
| May | 4 | 106 | 10 06·2 | +1·4 | +1·86 |
| June | 7 | 140 | 8 28·7 | +0·6 | ... |

Reduced lat. +1″·48. 2 obs.

*Black Spot .C.* R = $9^h\ 55^m\ 26^s.6$.

| Date. 1898. | Days. | T. h m | O—E. m | β ″ | L. ″ |
|---|---|---|---|---|---|
| Apr. 1 | 0 | 9 35·5 | +2·0 | ... | ... |
| 6 | 5 | 8 37·6 | −0·4 | ... | ... |
| 11 | 10 | 7 41·5 | −1·0 | +5·41 | 2·81 |
| 20 | 19 | 9 57·3 | −3·8 | ... | ... |
| May 7 | 36 | 8 54·0 | +0·3 | 5·04 | 2·50 |
| 12 | 41 | 7 59·8 | +0·7 | ... | ... |
| June 14 | 74 | 10 01·4 | +2·1 | ... | ... |

Mean reduced lat. +4″·41. 2 obs.
Length ... ... 2″·65. 2 obs.

*Long Black Spot.* R = $9^h\ 55^m\ 20^s.8$.

| 1899. | | | | | | |
|---|---|---|---|---|---|---|
| Mar. | 28 | 0 | 11 47·3 | +0·0 | ... | 2·5 est. |
| May | 1 | 34 | 9 25·3 | +6·8 | ... | 7·91 |
| | 8 | 41 | 9 51·1 | −7·0 | +6·03 | 2·54 |
| | 10 | 43 | 11 27·2 | −6·4 | ... | 2·5 est. |
| | 30 | 63 | 7 49·2 | +0·0 | ... | 7·33 |

Reduced lat. +5″·01.

*White Spot.* R = 9h 55m 20s·7.

| Date. 1899. | Days. | T. h m | O—E. s | β |
|---|---|---|---|---|
| May 27 | 0 | 7 35·6 | +0·0 | +4″·85 |
| 29 | 2 | 9 12·9 | +0·6 | ... |
| June 3 | 7 | 8 16·4 | +0·0 | ... |

Reduced lat. +3″·83.

*White Spot.* R = 9h 55m 32s·3.

| 1899. | | | | |
|---|---|---|---|---|
| Apr. 3 | 0 | 10 43·0 | +3·2 | +5·76 |
| 8 | 5 | 9 43·6 | −1·6 | ... |
| 25 | 22 | 8 38·0 | −0·6 | +6·22 |
| May 4 | 31 | 10 55·7 | −3·1 | ... |
| 26 | 53 | 8 59·1 | −0·4 | ... |
| 31 | 58 | 8 04·6 | −1·2 | ... |
| June 7 | 65 | 8 48·8 | −1·0 | ... |
| 9 | 67 | 10 29·6 | +1·8 | ... |
| 12 | 70 | 7 57·0 | +0·7 | +6·26 |
| 19 | 77 | 8 43·0 | +2·2 | ... |
| 24 | 82 | 7 51·7 | +3·9 | ... |
| 26 | 84 | 9 22·4 | −3·5 | +5·41 |
| July 1 | 89 | 8 34·2 | +1·1 | ... |
| 8 | 96 | 9 16·7 | −1·8 | +5·90 |

Mean reduced lat. +4″·89. 5 obs.

*White Spot.* R = 9h 55m 34s·2.

| 1899. | | | | |
|---|---|---|---|---|
| May 26 | 0 | 9 55·5 | +0·0 | ... |
| 31 | 5 | 9 04·2 | +2·0 | ... |
| June 7 | 12 | 9 41·6 | −5·2 | ... |
| 9 | 14 | 11 19·8 | −4·9 | ... |
| 12 | 17 | 8 51·8 | −2·0 | ... |
| 19 | 24 | 9 42·3 | +3·4 | ... |
| 24 | 29 | 8 48·0 | +1·7 | ... |

Reduced lat. +4″·9.

### *The Equatorial Belt.*

The two heavy belts on either side of the equator I designate the Equatorial Belt. During the past twenty years, systematic observations have been made of the position angle and latitude of the north edge, together with the total width of both portions

of the belt. During the past four years the width of each part of the belt has also been measured separately. In the Table of Observations :

P=position angle north edge.
$\beta$=distance from the apparent equator.
W=total width of the belts.
N=width of the north part.
S=width of the south part.
Long=Longitude in time from Marth-Crommelin Meridian...II.

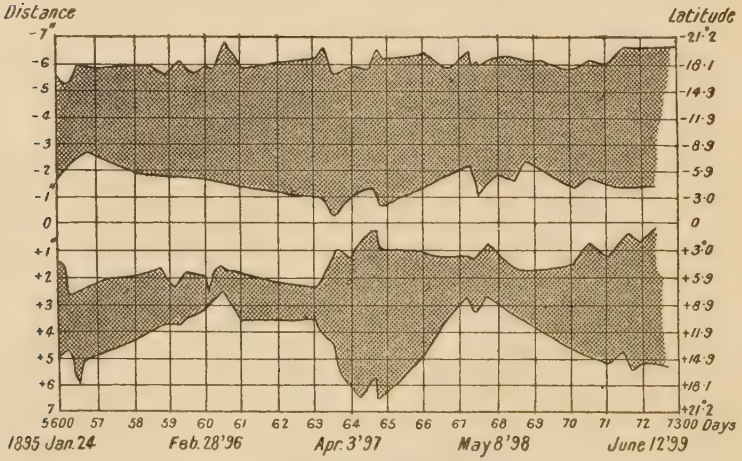
After correcting the apparent distances for the elevation of the Earth above *Jupiter's* equator, the diagram was plotted.

But on account of the short time scale only enough observations have been used to show the general displacement in latitude. It would of course be preferable to study the disturbance at the same longitude, but the observations are not sufficiently numerous for this purpose.

The diagram shows the position and magnitude, at any instant, of the two heavy belts on either side of the equator, which are designated the Equatorial Belt.

The numbers on the left are seconds of arc measured from the true equator ; those on the right, Jovicentric latitude.

The time intervals are each 100 days, and are counted from 1879 September 25. The dates at the bottom are given for every 400 days, 1895 January 24 corresponding to 5,600 days.




The diagram as plotted represents the average latitude and width of the belt around the whole circumference of the planet. If, however, the latitudes corresponding to any particular longitude are plotted, the curve will not vary materially from the diagram.

This diagram is of interest in showing at a glance the displacement in the material composing the two portions of the belt. In general, disturbances take place nearly at the same time on both sides of the planet's equator.

During the four years covered by these observations the north edge of the north belt shifted more than 3″ of arc, or 9 degrees of Jovicentric latitude ; the inner edge, which is not well defined, shifted about 2″, or 6 degrees. The south belt showed less fluctuation in latitude.

During the opposition of 1896 the north belt became very narrow—at times less than 1″ of arc in width—and remained pretty constant for more than 400 days. In 1897 it widened out to about 5″ of arc. It remained wide for 300 days, then narrowed to 1″·5, and again widened in 1899.

Whenever a change took place in the width of the belt the expansion or contraction seems to have been nearly symmetrical on both edges of the belt.

During the four years the centre of the north belt remained in approximately the same latitude—viz. +2″·5. Whether the centre of the belt remains stationary in latitude I am unable to answer, as my latitude measures in former years are confined to the outer edges of the belt only.

In 1897 both the north and south portions nearly reached the equator, and the open space between the belts was less than 2″ of arc. Now the question naturally arises, What became of the dark material composing the belts during the changes in magnitude ? Was it submerged, and so became invisible, or was it an actual dissipation of the matter of which it was composed ? I am as yet unable to answer the question.

An examination of the measures seems to show that the drift in latitude of the outer edges of the Equatorial Belt does not occur simultaneously through the whole circumference of the planet. The edges of the belt, however, remain practically parallel to the equator in all longitudes, as may be inferred from an examination of the position angles. I have noticed two marked exceptions, however. On 1882 October 3 there was a curved projection in longitude $+0^h\ 30^m$ following the great Red Spot. On October 14 the edge was smooth at the same longitude, and the whole belt had drifted so far north as to coalesce with $B_3$. Also on 1897 February 24, in longitude $+5^h$, the preceding half of the north edge of the belt had drifted about 2″ further north than the following portion. On February 27, however, the edge of the belt was comparatively smooth in the same longitude.

The mean position angle of the north edge of the belt referred to the equator of the planet as given in Marth-Crommelin Ephemerides was as follows :—

| Date. | Obs.—Eph. | No. Obs. |
|---|---|---|
| 1896 | +0°.34 | 18 |
| 1897 | +0.24 | 16 |
| 1898 | +0.78 | 13 |
| 1899 | +0.88 | 18 |
| Mean for 20 years ... ... ... ... | | +0.23 |

The maximum mean inclination was during the opposition of 1895 +1°.2.

It is extremely rare to find a marking inclined at any considerable angle to the equator.

While the displacement in latitude of the north edge of the equatorial belt has been so great, the black spots which have appeared near the margin of the belt since 1890 show very slight change in latitude from year to year.

From 1890 to 1899 the spots varied in latitude only 0″.57, while during the same period the north edge of the belt shifted 3″.7. Hence I infer that the spots lie at a different level—probably lower.

*The Equatorial Belt.*

| Date. | P. | β. | W. | N | S. | Long. |
|---|---|---|---|---|---|---|
| 1895. | ° | ″ | ″ | | | h |
| Sept. 16 | 105.5 | +3.90 | 10.08 | ... | ... | +2.0 |
| Oct. 29 | 107.1 | 3.62 | 9.73 | ... | ... | 4.3 |
| Nov. 4 | 108.5 | 3.63 | 9.44 | 1.98 | 4.09 | 6.7 |
| Dec. 9 | 107.0 | 4.11 | 10.13 | 1.18 | 4.16 | 6.1 |
| 15 | 107.3 | 3.53 | 9.41 | ... | ... | 0.2 |
| 21 | 107.9 | 3.34 | 10.08 | 1.62 | 4.74 | 6.9 |
| 30 | 105.7 | 3.14 | ... | ... | ... | 4.8 |
| 1896. | | | | | | |
| Jan. 6 | 106.8 | 3.35 | 9.15 | 1.86 | 4.44 | 2.8 |
| 9 | 106.3 | 3.59 | 9.71 | 1.88 | 4.43 | 4.4 |
| 13 | ... | 3.70 | 9.55 | ... | ... | 2.0 |
| 29 | 105.0 | 3.77 | ... | 1.30 | 4.34 | 8.0 |
| 30 | 105.4 | 3.13 | ... | ... | ... | 1.5 |
| Feb. 5 | ... | 3.70 | 9.74 | 1.43 | 3.85 | 6.0 |
| 8 | 106.0 | 2.89 | 9.06 | ... | ... | 9.7 |
| 11 | 105.0 | 3.54 | 9.42 | ... | ... | 1.7 |
| 28 | 104.0 | 3.08 | 9.27 | 1.31 | 4.43 | 1.2 |
| Mar. 2 | 104.5 | 4.02 | ... | ... | ... | 5.0 |
| 3 | 104.4 | 3.22 | 9.55 | ... | ... | 8.7 |
| 4 | ... | 3.19 | 9.58 | 0.66 | 3.92 | 2.5 |
| 16 | 104.6 | 2.95 | 8.92 | 1.48 | 4.24 | 3.4 |
| 19 | ... | 3.02 | 9.26 | ... | ... | 6.3 |
| 23 | ... | +3.02 | 9.03 | ... | ... | 1.8 |

| Date. | P. | β | W. | N. | S. | Long. |
|---|---|---|---|---|---|---|
| 1896. | ° | ″ | ″ | | | h |
| Apr. 2 | ... | +2·99 | 9·02 | 0·67 | 4·11 | 6·0 |
| 3 | ... | 2·82 | 8·75 | ... | ... | 0·0 |
| 6 | ... | 2·88 | 8·81 | 0·82 | 3·96 | 0·6 |
| 21 | 104·0 | 2·33 | 9·41 | 1·02 | 3·78 | 3·2 |
| May 2 | 104·8 | 2·80 | 9·28 | 0·74 | 4·19 | 8·5 |
| 9 | ... | 3·29 | 9·54 | 0·95 | 4·28 | 8·5 |
| 25 | ... | 2·59 | 9·11 | 1·25 | 4·19 | 5·5 |
| 26 | ... | 3·29 | ... | ... | ... | 8·6 |
| June 5 | ... | 3·43 | 9·41 | ... | ... | 1·5 |
| Dec. 12 | ... | 3·90 | 9·80 | ... | ... | 7·4 |
| 1897. | | | | | | |
| Jan. 17 | 113·5 | 4·42 | 10·68 | 1·20 | 5·50 | 7·4 |
| 20 | 114·4 | 4·59 | 9·96 | ... | 4·96 | 1·0 |
| Feb. 2 | 114·4 | 3·35 | 8·45 | 0·90 | 4·98 | 2·0 |
| 13 | ... | 4·80 | 9·82 | ... | ... | 9·3 |
| 20 | 112·8 | 5·11 | 10·45 | 2·70 | 5·40 | 6·4 |
| 24 | 113·4 | 4·49 | 10·45 | ... | ... | 5·0 |
| 27 | 113·5 | 6·23 | 10·62 | ... | ... | 5·0 |
| Mar. 1 | 114·7 | 5·72 | 11·21 | 4·15 | 5·54 | 5·0 |
| 3 | 114·0 | 6·62 | 11·25 | 4·04 | 4·87 | 3·0 |
| 10 | ... | 6·25 | 11·36 | 3·52 | 4·98 | 2·0 |
| 12 | ... | 6·01 | 11·33 | ... | ... | 1·1 |
| 15 | ... | 5·23 | 11·39 | 3·77 | 4·99 | 3·0 |
| 20 | 113·5 | 5·94 | 11·50 | 3·92 | 5·48 | 3·1 |
| Apr. 9 | 113·8 | 6·33 | 12·01 | 4·66 | 4·93 | 6·5 |
| 10 | ... | 6·10 | 11·42 | ... | ... | 3·0 |
| 16 | ... | 6·03 | 12·22 | 5·98 | 5·02 | 7·0 |
| 23 | 113·8 | 6·17 | 12·79 | 5·11 | 5·68 | 5·0 |
| 24 | 113·1 | 6·29 | 12·44 | 5·83 | 5·48 | 0·1 |
| May 16 | 113·8 | 6·87 | 12·64 | 5·59 | 5·25 | 1·0 |
| 24 | 112·9 | 6·44 | 11·75 | 5·42 | 5·27 | 4·0 |
| 26 | ... | 5·95 | ... | ... | ... | 3·1 |
| 30 | ... | 5·82 | ... | 5·38 | 5·16 | 8·9 |
| June 1 | 113·9 | 6·26 | 12·03 | ... | ... | 7·0 |
| 2 | ... | 6·01 | 12·24 | 5·72 | 5·72 | 2·0 |
| 7 | ... | 6·00 | 12·71 | 6·18 | 6·18 | 2·7 |
| 12 | ... | 6·05 | 12·42 | 4·90 | 4·90 | 4·0 |
| 21 | ... | 6·32 | 11·98 | 5·66 | 5·66 | 8·9 |
| 22 | 113·4 | 6·55 | 12·71 | 5·54 | 5·65 | 5·0 |
| 29 | ... | +6·73 | 12·76 | ... | ... | 4·1 |

| Date. | P. | β | W. | N. | S. | Long. |
|---|---|---|---|---|---|---|
| 1897. | ° | ″ | ″ | | | h |
| Oct. 25 | 115·3 | +5·51 | 11·35 | ... | ... | 3·0 |
| 1898. | | | | | | |
| Jan. 13 | ... | 3·96 | 9·00 | ... | ... | 0·0 |
| Feb. 13 | ... | 3·79 | 9·66 | 1·74 | 4·49 | 5·0 |
| 26 | 114·5 | 3·63 | 9·37 | 1·67 | 5·10 | 6·1 |
| Mar. 2 | ... | 4·00 | 8·85 | ... | ... | 2·5 |
| 4 | ... | 4·08 | 9·55 | ... | ... | 0·0 |
| 7 | ... | 3·97 | 9·42 | 2·05 | 4·63 | 2·0 |
| 13 | ... | 4·02 | 8·61 | 1·80 | 4·45 | 7·8 |
| 16 | ... | 4·91 | 8·99 | ... | ... | 2·5 |
| 19 | 116·3 | 4·23 | 9·41 | 2·06 | 4·93 | 2·6 |
| 28 | ... | 3·61 | 9·57 | ... | ... | 0·1 |
| 30 | 116·8 | 3·93 | 8·66 | 1·90 | 4·83 | 8·4 |
| Apr. 5 | ... | 3·62 | 8·81 | 1·88 | 4·39 | 1·0 |
| 11 | 116·1 | 3·61 | 9·33 | 2·17 | 4·09 | 7·9 |
| 15 | 115·7 | 4·03 | 9·72 | ... | ... | 4·8 |
| 20 | 116·1 | 3·81 | 9·13 | 1·81 | 4·02 | 4·0 |
| 30 | 116·5 | 4·02 | 9·60 | ... | ... | 6·0 |
| May 3 | ... | 4·23 | 9·72 | 2·56 | 5·01 | 8·9 |
| 7 | 118·8 | 4·10 | 9·66 | 1·91 | 4·19 | 5·5 |
| 21 | 118·1 | 3·76 | 9·65 | ... | ... | 5·0 |
| 23 | 116·0 | 3·62 | 9·45 | ... | ... | 3·1 |
| 30 | 116·7 | 3·31 | 9·47 | ... | ... | 3·0 |
| June 4 | 116·2 | 3·79 | 8·93 | 1·34 | 4·45 | 2·9 |
| 14 | 114·8 | 3·74 | ... | 2·02 | 5·01 | 4·7 |
| 28 | 117·0 | 3·84 | 9·27 | 1·16 | 4·73 | 3·3 |
| July 6 | ... | 4·10 | 9·51 | ... | ... | 6·3 |
| 16 | ... | 4·20 | 9·90 | 1·87 | 3·84 | 7·6 |
| Dec. 10 | ... | 5·79 | 10·68 | 3·23 | 4·32 | 0·0 |
| 1899. | | | | | | |
| Jan. 14 | ... | 5·46 | 10·61 | 4·32 | 4·32 | 6·0 |
| Feb. 28 | ... | 4·65 | 10·00 | ... | ... | 0·1 |
| Mar. 13 | ... | [6·25] | [11·73] | ... | ... | 6·5 |
| 23 | 112·8 | 5·92 | 10·49 | 3·82 | 4·74 | 2·5 |
| 28 | ... | 5·66 | 10·58 | ... | ... | 4·5 |
| Apr. 3 | 111·6 | 5·76 | 11·36 | ... | ... | 8·4 |
| 4 | 111·4 | 5·54 | 10·96 | ... | ... | 2·7 |
| 7 | ... | 5·54 | 11·02 | ... | ... | 5·2 |
| 8 | 111·3 | 5·49 | 11·03 | ... | ... | 8·3 |
| 23 | ... | +5·84 | 11·58 | ... | ... | 0·8 |

| Date. 1899. | P. | β | W. | N. | S. | Long. |
|---|---|---|---|---|---|---|
| | ° | ″ | ″ | | | h |
| Apr. 25 | 112·1 | +4·96 | 10·30 | 3·67 | 4·50 | 0·0 |
| 28 | 112·8 | 6·45 | 11·14 | 4·50 | 5·10 | 4·0 |
| May 1 | ... | 5·98 | 11·31 | ... | ... | 3·7 |
| 4 | 112·1 | 6·51 | 11·65 | 4·68 | 4·94 | 6·9 |
| 8 | ... | 5·79 | 11·02 | ... | ... | 4·0 |
| 10 | ... | 6·07 | 11·70 | ... | ... | 3·5 |
| 17 | 112·1 | 6·44 | 12·30 | 5·47 | 5·52 | 1·5 |
| 18 | ... | 6·27 | 11·98 | ... | ... | 7·0 |
| 27 | 112·1 | 6·60 | 11·54 | 4·26 | 5·03 | 2·0 |
| 29 | ... | 6·05 | 11·08 | ... | ... | 1·0 |
| 30 | ... | 6·39 | ... | ... | ... | 4·1 |
| 31 | ... | 6·08 | 11·00 | ... | ... | 8·9 |
| June 3 | ... | 6·08 | 10·50 | ... | ... | 1·0 |
| 7 | 111·5 | 6·10 | 11·94 | 4·81 | 4·21 | 8·9 |
| 9 | 111·6 | 6·63 | 11·19 | ... | ... | 6·7 |
| 10 | 111·7 | 6·20 | 12·14 | 5·59 | 4·92 | 2·0 |
| 11 | ... | 6·16 | 11·55 | ... | ... | 5·6 |
| 13 | ... | 5·58 | 11·35 | 4·41 | 4·55 | 4·1 |
| 16 | ... | 6·16 | 11·54 | ... | ... | 6·0 |
| 20 | ... | 5·87 | 11·44 | 4·63 | 4·91 | 3·1 |
| 21 | ... | 5·97 | 11·28 | ... | ... | 7·0 |
| 23 | ... | 6·16 | 11·85 | ... | ... | 6·5 |
| 24 | 110·9 | 6·20 | 11·62 | ... | ... | 0·0 |
| 25 | ... | 6·68 | 11·85 | 5·39 | 5·39 | 2·4 |
| 26 | ... | 5·86 | 11·47 | ... | ... | 7·9 |
| 29 | ... | 6·16 | 11·87 | ... | ... | 0·0 |
| 30 | 111·9 | 6·23 | 11·64 | ... | ... | 3·5 |
| July 5 | ... | 6·15 | ... | ... | ... | 4·6 |
| 8 | ... | 6·47 | 11·26 | 4·64 | 4·88 | 6·5 |
| 11 | 111·9 | 6·63 | 11·70 | ... | ... | 0·0 |
| 17 | 111·9 | 6·12 | 12·06 | 5·04 | 5·04 | 4·6 |
| 19 | ... | 6·37 | 12·16 | ... | ... | 3·0 |
| 21 | ... | 6·30 | 12·22 | ... | ... | 0·1 |
| 29 | ... | 6·12 | 11·90 | ... | ... | 4·2 |
| Aug. 9 | 111·9 | 6·38 | 12·52 | ... | ... | 0·0 |
| 25 | 110·7 | +6·10 | 11·90 | ... | ... | 6·0 |

The following are the mean values for the reduced latitude of the north and south edges of the Equatorial Belt during each opposition :—

*Reduced Latitude.*

| Mean Day. | | N. Edge. | No. Obs. | S. Edge. | No. Obs. |
|---|---|---|---|---|---|
| 1896 Mar. 1 | 6001 | +3".44 | 20 | −5".97 | 20 |
| 1897 Apr. 11 | 6408 | +5·30 | 29 | −6·10 | 27 |
| 1898 " 11 | 6773 | +3·16 | 27 | −6·16 | 26 |
| 1899 May 23 | 7180 | +5·06 | 48 | −6·36 | 46 |

*Conclusions.*

1. The surface density of the planet *Jupiter* is presumably less than one-half that of water. The experiments made during the past twenty-five years in the liquefaction of air and gases enable us to imagine a plastic medium of the probable density of the planet.

If, then, the objects we observe are located at different levels in this medium, it would enable us to understand better why spots in the same latitude give different rotation periods.

2. The great Red Spot, 27,000 miles long, 8,000 miles wide, and possibly as deep as it is wide, drifts in both longitude and latitude.

It is the most stable of any marking seen on the disk. Its visibility may depend on its greater or less submergence beneath the surface, and its rate of drift (rotation period) may also be due to the same cause.

3. The rotation of the whole surface of the planet, on which spots or markings have been observed, is performed in $9^h\ 55^m$ to $56^m$. The true rotation of the planet, however, may be slower than the longest rotation period hitherto observed, in which case all objects would drift in the same direction. My observations during the past twenty years extend from $+37°$ to $-38°$ of jovicentric latitude. Very few rotation periods have ever been determined outside these limits.

4. The rotation period is not constant for any latitude, but usually varies with the time.*

5. There is apparently no direct connection between latitude and rotation period, as is sometimes alleged.†

6. The rotation periods determined from spots or markings lying in the same latitude and at the same opposition may differ *inter se* 30 seconds or more. Hence the conclusions deduced by some observers for various permanent currents *on the surface of* the planet are based on insufficient data.

7. In the equatorial region from $+11°$ to $-8°$ of jovicentric latitude is found a rotation period $9^h\ 50^m \pm$, and this shorter period may possibly extend to 20° of latitude.

* Vide *A.N.* 3354.

† Vide *P.A.*, February 1899, Table of Rotation Periods.

8. The periods $9^h\ 55^m+$ and $9^h\ 50^m\pm$ are found in the same latitude, and probably at the same time.

9. It seems to me that the complicated motions observed on the surface of the planet are best explained by assuming the existence of a number of layers, or strata, at different depths below the surface, in which are located the objects under observation.

*Observations of Minor Planets at Windsor, N.S. Wales.* By John Tebbutt.

The accompanying observations have been made with the filar-micrometer on the 8-inch equatorial refractor, and in a bright field. The reductions have been made with a new and improved value (17″·813) of a revolution of the micrometer screw, and the differential coordinates have been corrected for refraction and a small error in the perpendicularity of the micrometer threads. The corrections to the ephemeris of *Vesta* in the *Nautical Almanac*, and to that of *Iris* in the *Ast. Jahrbuch* have been kindly supplied by Mr. Merfield, F.R.A.S., of Sydney. The observations of the latter planet have been made expressly for Dr. J. Riem's proposed improved tables of *Iris*.

*Observations.*

| 1899. | Windsor Mean Time. | Planet—Star. Δ R.A. | Δ N.P.D. | Comps. | Reductions to App. Place R.A. | N.P.D. | Planet's Apparent R.A. | N.P.D. | Log $p$ Δ for R.A. | N.P.D. | Star. | Obs.—Cal. R.A. | N.P.D. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (4) *Vesta.* | | | | | | |
| | h m s | m s | ′ ″ | | s | | h m s | ° ′ ″ | | | | s | ″ |
| Oct. 31 | 8 38 17 | +5 26·50 | − 8 30·4 | 10 | +4·69 | −27·4 | 1 20 58·14 | 93 37 39·9 | 9·4067*n* | 0·6494 | 1 | +2·15 | −12·9 |
| Nov. 1 | 8 25 49 | +4 37·24 | − 6 30·5 | 10 | +4·69 | −27·3 | 1 20 8·88 | 93 39 39·9 | 9·4300*n* | 0·6500 | 1 | +2·17 | −13·5 |
| 7 | 8 59 30 | +0 1·20 | + 1 14·0 | 15 | +4·69 | −26·8 | 1 15 32·84 | 93 47 24·9 | 9·1729*n* | 0·6430 | 1 | +2·05 | −13·0 |
| 8 | 8 5 10 | −0 38·65 | + 1 43·8 | 20 | +4·69 | −26·7 | 1 14 52·99 | 93 47 54·8 | 9·3924*n* | 0·6471 | 1 | +2·03 | −14·2 |
| 9 | 8 52 33 | −1 20·15 | + 2 3·9 | 10 | +4·69 | −26·7 | 1 14 11·49 | 93 48 14·9 | 9·1592*n* | 0·6427 | 1 | +1·98 | −14·1 |
| 10 | 7 47 24 | −1 56·91 | + 2 10·1 | 7 | +4·69 | −26·6 | 1 13 34·73 | 93 48 21·2 | 9·4196*n* | 0·6480 | 1 | +1·84 | −13·9 |
| 14 | 9 24 1 | −4 19·80 | + 0 26·7 | 9 | +4·68 | −26·3 | 1 11 11·83 | 93 46 38·1 | 8·4722*n* | 0·6410 | 1 | +1·94 | −13·4 |

| | Windsor Mean Time. | Planet—Star. Δ R.A. | Δ N.P.D. | Comps. | Reductions to App. Place R.A. | N.P.D. | Planet's Apparent R.A. | N.P.D. | Log $p\,\Delta$ for R.A. | N.P.D. | Star. | Obs.—Cal. R.A. | N.P.D. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (7) *Iris.* | | | | | | | | |
| 1899. | h m s | m s | ′ ″ | | s | ″ | h m s | ° ′ ″ | | | | s | ″ |
| Oct. 17 | 10 36 38 | −0 15·16 | −16 38·3 | 20 | +4·91 | −28·9 | 1 12 47·91 | 71 40 10·7 | 9·0747*n* | 0·8377 | 2 | +2·03 | − 6·8 |
| 18 | 10 11 0 | −1 0·92 | − 8 57·7 | 20 | +4·92 | −28·9 | 1 12 2·16 | 71 47 51·3 | 9·2156*n* | 0·8333 | 2 | +2·11 | − 7·1 |
| 23 | 9 30 1 | −5 46·93 | ... | 3 | +4·94 | ... | 1 8 18·04 | ... | 9·3026*n* | ... | 3 | +2·34 | ... |
| 23 | 9 30 1 | −6 43·26 | ... | 3 | +4·94 | ... | 1 8 18·22 | ... | 9·3026*n* | ... | 4 | +2·52 | ... |
| 23 | 9 30 1 | −7 10·49 | +10 26·5 | 3 | +4·94 | −29·2 | 1 8 17·62 | 72 28 50·6 | 9·3026*n* | 0·8254 | 5 | +1·92 | −12·4 |
| 25 | 9 12 21 | −3 59·05 | − 7 17·9 | 5 | +4·92 | −29·6 | 1 6 53·64 | 72 46 7·7 | 9·3380*n* | 0·8218 | 6 | +2·19 | − 7·7 |
| 31 | 10 0 14 | −2 40·59 | − 5 30·0 | 10 | +4·90 | −30·1 | 1 3 6·62 | 73 39 31·4 | 8·7397*n* | 0·8285 | 7 | +2 29 | −10·8 |
| 31 | 10 0 14 | −4 26·18 | − 6 13·3 | 10 | +4·91 | −30·0 | 1 3 6·03 | 73 39 33·5 | 8·7397*n* | 0·8285 | 8 | +1·70 | − 8·7 |
| Nov. 1 | 9 51 41 | −3 12·84 | + 3 18·8 | 10 | +4·90 | −30·2 | 1 2 34·37 | 73 48 20·1 | 8·8055*n* | 0·8274 | 7 | +2·35 | −11·5 |
| 1 | 9 51 41 | −4 58·44 | + 2 35·4 | 10 | +4·91 | −30·1 | 1 2 33·77 | 73 48 22·1 | 8·8055*n* | 0·8274 | 8 | +1·75 | − 9·5 |
| 7 | 10 25 20 | +2 9·35 | +16 47·8 | 10 | +4·85 | −30·7 | 0 59 55·54 | 74 40 35·7 | 8·8429 | 0·8214 | 9 | +2·00 | − 9·3 |
| 9 | 10 7 18 | −3 17·22 | ... | 10 | +4·86 | ... | 0 59 18·92 | ... | 8·6833 | ... | 10 | +2·09 | ... |
| 9 | 10 7 18 | −5 36·12 | + 5 44·7 | 10 | +4·87 | −30·4 | 0 59 18·83 | 74 57 3·1 | 8·6833 | 0·8203 | 11 | +2·00 | − 8·4 |
| 17 | 8 52 37 | +3 46·04 | + 0 59·6 | 15 | +4·77 | −30·8 | 0 58 16·11 | 75 56 35·8 | 8·6567*n* | 0·8135 | 12 | +1·73 | − 6·0 |
| 18 | 8 35 46 | +3 48·01 | + 7 33·5 | 15 | +4·77 | −30·8 | 0 58 18·08 | 76 3 9·7 | 8·8686*n* | 0·8120 | 12 | +1·76 | − 6·3 |
| 19 | 8 40 41 | +3 52·22 | +14 2·2 | 15 | +4·76 | −30·8 | 0 58 22·28 | 76 9 38·4 | 8·7369*n* | 0·8118 | 12 | +1·85 | − 4·9 |
| 20 | 9 7 26 | −0 8·45 | −19 48·9 | 20 | +4·77 | −30·4 | 0 58 28·35 | 76 15 59·9 | 8·1175 | 0·8117 | 13 | +1·51 | − 3·8 |

| 1899. | Windsor Mean Time. | Planet—Star. Δ R.A. | Planet—Star. Δ N.P.D. | Comps. | Reductions to App. Place R.A. | Reductions to App. Place N.P.D. | Planet's Apparent R.A. | Planet's Apparent N.P.D. | Log $p$ Δ for R.A. | Log $p$ Δ for N.P.D. | Star. | Obs.—Cal. R.A. | Obs.—Cal. N.P.D. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m s | m s | ′ ″ | | s | ″ | h m s | ° ′ ″ | | | | s | ″ |
| Nov. 23 | 9 0 53 | +0 23·95 | − 2 32·7 | 20 | +4·75 | −30·4 | 0 59 0·73 | 76 33 16·1 | 8·3716 | 0·8097 | 13 | +1·61 | − 4·8 |
| 24 | 9 1 33 | +0 39·18 | + 2 45·5 | 20 | +4·75 | −30·4 | 0 59 15·96 | 76 38 34·3 | 8·5193 | 0·8088 | 13 | +1·66 | − 5·3 |
| 25 | 8 52 32 | +0 56·43 | + 7 48·4 | 15 | +4·74 | −30·4 | 0 59 33·20 | 76 43 37·2 | 8·3286 | 0·8083 | 13 | +1·64 | − 4·8 |
| 26 | 8 42 40 | +1 15·86 | +12 35·8 | 15 | +4·73 | −30·4 | 0 59 52·62 | 76 48 24·6 | 7·8748 | 0·8080 | 13 | +1·66 | − 5·5 |
| 27 | 9 0 17 | +1 37·85 | +17 14·7 | 15 | +4·73 | −30·4 | 1 0 14·61 | 76 53 3·5 | 8·7332 | 0·8068 | 13 | +1·72 | − 5·5 |
| 28 | 9 11 58 | +7 57·42 | + 6 57·8 | 8 | +4·69 | −30·5 | 1 0 38·62 | 76 57 27·5 | 8·9414 | 0·8053 | 14 | +1·70 | − 4·5 |
| Dec. 5 | 9 10 8 | +3 5·12 | −13 38·8 | 10 | +4·68 | −29·8 | 1 4 24·54 | 77 20 58·8 | 9·1285 | 0·8000 | 15 | +1·47 | − 3·7 |
| 8 | 9 26 10 | +5 13·13 | − 7 16·1 | 10 | +4·66 | −29·6 | 1 6 32·53 | 77 27 21·7 | 9·2740 | 0·7954 | 15 | +1·54 | − 4·1 |
| 12 | 8 44 54 | +2 35·72 | + 3 4·5 | 14 | +4·67 | −29·2 | 1 9 47·75 | 77 32 25·2 | 9·1066 | 0·7990 | 16 | +1·44 | − 5·6 |
| 14 | 8 24 12 | +4 24·04 | + 4 14·9 | 10 | +4·65 | −29·2 | 1 11 36·05 | 77 33 35·6 | 8·9834 | 0·8004 | 16 | +1·33 | − 5·3 |
| 16 | 9 14 50 | +6 22·08 | + 4 31·9 | 10 | +4·63 | −29·1 | 1 13 34·07 | 77 33 52·7 | 9·3313 | 0·7919 | 16 | +1·29 | − 5·1 |
| 17 | 8 57 54 | +7 22·01 | + 4 21·2 | 10 | +4·62 | −29·1 | 1 14 33·99 | 77 33 42·0 | 9·2697 | 0·7946 | 16 | +1·30 | − 4·5 |
| 22 | 8 53 28 | +4 26·77 | − 9 55·8 | 10 | +4·63 | −28·3 | 1 20 0·83 | 77 29 39·7 | 9·3138 | 0·7933 | 17 | +1·48 | − 3·6 |
| 23 | 9 15 32 | +5 37·79 | −11 22·5 | 8 | +4·62 | −28·3 | 1 21 11·84 | 77 28 13·0 | 9·4061 | 0·7880 | 17 | +1·46 | − 4·4 |
| 25 | 8 38 57 | −3 54·28 | + 3 52·9 | 10 | +4·69 | −27·6 | 1 23 34·35 | 77 24 52·1 | 9·2865 | 0·7951 | 18 | +1·36 | − 4·5 |
| 26 | 8 22 55 | −2 40·82 | + 1 56·3 | 10 | +4·68 | −27·5 | 1 24 47·80 | 77 22 55·6 | 9·2202 | 0·7976 | 18 | +1·29 | − 4·0 |
| 29 | 8 52 36 | +1 12·08 | − 5 6·6 | 20 | +4·65 | −27·4 | 1 28 40·67 | 77 15 52·8 | 9·3834 | 0·7908 | 18 | +1·33 | − 4·9 |
| 30 | 9 2 36 | +2 32·45 | − 7 47·6 | 12 | +4·64 | −27·3 | 1 30 1·03 | 77 13 11·9 | 9·4247 | 0·7879 | 18 | +1·34 | − 4·2 |

*Mean Places of the Comparison Stars for* 1899·0.

| Star. | R.A. h m s | N.P.D. ° ′ ″ | Authorities. |
|---|---|---|---|
| 1 | 1 15 26·95 | 93 46 37·7 | Yarnall$_3$, 677; Argent. Gen. Cat. 1258; Radcliffe, 1890, 310. |
| 2 | 1 12 58·16 | 71 57 17·9 | Wash. Gen. Cat. 1875, 310; Radcliffe, 1890, 304; Cincinnati, 1890, 185. |
| 3 | 1 14 0·03 | ... | Lalande, 2369. |
| 4 | 1 14 56·54 | ... | Lalande, 2400–1. |
| 5 | 1 15 23·17 | 72 18 53·3 | Lalande, 2411–4; Cincinnati, 1890, 192. |
| 6 | 1 10 47·77 | 72 53 55·2 | Wash. Gen. Cat. 1875, 298; Radcliffe, 1890, 296; Cincinnati, 1890, 181. |
| 7 | 1 5 42·31 | 73 45 31·5 | Lalande, 2103. |
| 8 | 1 7 27·30 | 73 46 16·8 | Lalande, 2158. |
| 9 | 0 57 41·34 | 74 24 18·6 | Wash. Gen. Cat. 1875, 236; Radcliffe, 1890, 226; Cincinnati, 1890, 138. |
| 10 | 1 2 31·28 | ... | Wash. Gen. Cat. 1875, 265; Radcliffe, 1890, 257; Cincinnati, 1890, 151. |
| 11 | 1 4 50·08 | 74 51 48·8 | Wash. Gen. Cat. 1875, 279; Radcliffe, 1890, 267; Cincinnati, 1890, 164. |
| 12 | 0 54 25·30 | 75 56 7·0 | Wash. Gen. Cat. 1875, 222; Radcliffe, 1890, 212; Cincinnati, 1890, 129. |
| 13 | 0 58 32·03 | 76 36 19·2 | Radcliffe, 1890, 230; Cincinnati, 1890, 140. |
| 14 | 0 52 36·51 | 76 51 0·2 | Yarnall$_3$, 506; Wash. Gen. Cat. 1875, 212; Greenwich, 1880, 149; Radcliffe, 1890, 202; Cincinnati, 1890, 126; Glasgow, 1890, 76. |
| 15 | 1 1 14·74 | 77 35 7·4 | Greenwich, 1880, 177; Radcliffe, 1890, 246; Glasgow, 1890, 86. |
| 16 | 1 7 7·36 | 77 29 49·9 | Yarnall$_3$, 626. |
| 17 | 1 15 29·43 | 77 40 3·8 | Yarnall$_3$, 676. |
| 18 | 1 27 23·94 | 77 21 26·8 | Lalande, 2806. |

*Observatory, Peninsula, Windsor, N.S. Wales:*
1900 *March* 10.

## *Supplementary Observations of Minor Planet* (7) *Iris.*

By John Tebbutt.

In addition to the equatorial observations of (7) *Iris* already forwarded, the planet was observed four times on the meridian with the 3-inch transit instrument, with the following results. The corrections (Obs.–Cal.) to the *Jahrbuch* Ephemeris have been kindly furnished by Mr. Merfield.

| Windsor Mean Time, 1899. | Approx. R.A. of Planet. | Correction to Ephemeris. |
|---|---|---|
| d h m s | h m s | s |
| Nov. 18 9 9 12 | 0 58 18·17 | +1·86 |
| 25 8 42 56 | 0 59 33·20 | +1·74 |
| 28 8 32 12 | 1 0 37·91 | +1·59 |
| Dec. 1 8 21 48 | 1 2 1·98 | +1·61 |

*Observatory, Peninsula, Windsor, N.S. Wales :*
1900 *April* 2.

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*Errata in Mr. Tebbutt's Papers.*

Vol. lviii. page 467, line 10 from top, *for* extend *read* entered.

„ lix. „ 543, „ 21–22 from top, *for* catalogue, in two places, *read* catalogues.

„ lix. „ 543, „ 26 from top, *for* 1 *read* 71.

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